THE

HEAVENS SURVEY'D,

AND THE

True SYSTEM of the UNIVERSE

Delineated, ſo as to form a Curious

ASTRONOMICAL INSTRUMENT:

EXHIBITING

The *Number*, *Order*, *Periods*, *Aphelions*, *Perihelions*, *Nodes*, &c. of all the PRIMARY PLANETS by Inſpection:

TOGETHER WITH

An eaſy and expeditious Method of aſcertaining by the ſame Inſtrument, and a new Set of Tables, their *Anomalies*, *Longitudes*, *Latitudes*, *Retrogradations*, *Conjunctions*, *Elongations*, and *Diſtances* at all Times, both *Heliocentric* and *Geocentric*; that is, as ſeen from the *Sun* and from the *Earth*; and alſo from one another.

In the Courſe of the Work is met with

A *View of the Syſtem from the Earth*, elucidating and explaining the true Cauſes of the *Directions* and *Retrogradations* of the Planets; and of the various *Phaſes* they exhibit to us here: With the Reaſons of the *Tranſits* of *Venus* and *Mercury* over the *Sun*; the Times when they happen;---and an eaſy Method of delineating the Tracks thoſe Planets take in paſſing over his *Diſk*.----Alſo, the remarkable Path which the Planet *Mars* ſeemed to deſcribe in the Heavens in the year 1762.

The whole adapted to the NEW STYLE;

And conſtructed in a Manner ſo eaſy and natural, as to convey to the *Aſtronomical Learner* a perfect *Knowledge* of the *Solar Syſtem* at firſt View.

Addreſſed to the YOUTH of GREAT BRITAIN and IRELAND.

By the Reverend Mr. TURNER, late of *Magdalen Hall*, *Oxford*;

Author of the *View of the Heavens*;-----*View of the Earth*;-----*Trigonometry rendered Eaſy and Familiar*;-----*Syſtem of Gauging*;----*Chronologer Perpetual*;——*and a New Introduction to Book-Keeping*.

Rector of *Comberton*; Vicar of *Elmley*; Miniſter of *Norton*, and Chaplain to the Right Honourable the Counteſs Dowager of *Wigton*.

——*Cœlique Meatus*
Deſcribent Radio; *et ſurgentia Sidera dicent*. VIRG.

LONDON;

Printed for S. CROWDER, at No. 12, Pater-noſter-Row;
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A

VIEW of the HEAVENS:

Being a Short, but Comprehenſive,

SYSTEM

OF

MODERN ASTRONOMY.

EXHIBITING,

I. The Number, Order, Diſtances, Magnitudes, and Periods of all the Planets and their ſeveral Moons, compoſing our Syſtem, which the Learning of the preſent Age eſteems as ſo many Worlds full of Inhabitants.

II. The length of the Day and Year, with the Variety of the Seaſons in each Planet; and alſo the Phænomena of the Heavens to the Inhabitants thereof.

III. Some Account of the Comets, their Number, Period, and Appearances; and alſo the Directions of their fiery Trains thro' the Heavens; with probable Conjectures of the Uſes of thoſe amazing Bodies.

IV. The Number, Magnitude, and Diſtances of the Fixed Stars; with their Diviſions into Signs, Catalogues, and Conſtellations.

V. The true Figure of the Planets' Orbits, with the Nature of the Motions in them; their Aphelions, Perihelions, Eccentricities, Nodes, &c. &c.

VI. The Inequality in the Length of the Natural Day, commonly called the Equation of Time.

VII. The Power that retains the Earth and Planets in their Orbits.

VIII. The direct and retrograde Motions of all the Planets; as alſo, the Reaſons why they ſometimes appear ſtationary, or not to move at all.

IX. The Nature and Cauſes of Eclipſes, both of the Sun and Moon; with an eaſy and expeditious Method of calculating the Eclipſes which will happen in any Year.

X. The Deſcription and Uſe of a curious Aſtronomical Clock, which will ſhew the Hour of the Night by the Stars.

TO WHICH IS ADDED,

The Uſe of the CÆLESTIAL GLOBE:

WITH

Its Application to a Number of very intereſting Problems. Concluding with ſome curious Phænomena upon the Sun and Moon exhibited in a darkened Room; and a few ſelect Paradoxes, intended to excite the Attention of the Learner.

The whole illuſtrated with Copper-plates of the Syſtem, the Sun, Moon, Eclipſes, &c. and diſpoſed in ſo eaſy and natural a Manner, as to be underſtood in a few Days.

THE SECOND EDITION, WITH MANY ADDITIONS AND IMPROVEMENTS.

By the Rev. Mr. TURNER, of *Magdalen-Hall, Oxford*;

Rector of *Comberton*;—Vicar of *Elmley*;—Miniſter of *Norton*;—and Chaplain to the Right Honourable the Counteſs Dowager of *Wigton*.——Author of The Heavens Survey'd;——The View of the Earth;—Plain Trigonometry rendered Eaſy and Familiar;—Syſtem of Gauging;—Chronologer Perpetual;——and a New Introduction to Book-keeping.

The WORLDS were framed by the WORD *of* GOD. PAUL.

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TO THE

READER.

ASTRONOMY in all Ages has been cultivated not only by Men of the greateſt *Genius*, but thoſe of the higheſt *Honours*.——*Kings* as well as *Philoſophers* have ſtudied the Revolutions of the glowing Worlds above, and made them uſeful to us, by meaſuring out our *Dates* and *Time* here on Earth.

The vaſt Advantages derived to Mankind from thence, together with the Pleaſures reſulting from this *Heavenly Science*, induced me to draw up this new Work for the Youth of theſe Kingdoms; which, as it is now become a Science ſo neceſſary in *civil* and *ſacred* Life, and of which every Perſon (who would be a Scholar) ſhould have ſome Knowledge, I have attempted in a Manner as eaſy and engaging as poſſibly I could.

With this View I have ſuppoſed the *young Aſtronomer* transferred from the *Earth* to the *Sun*, where he may the better behold the ſeveral Worlds wheel round him, and obſerve their various *Diſtances*, *Periods*, *Dimenſions*, *Inclinations* of their *Axes* and *Orbits*, *Aphelions*, *Peribelions*, and *Nodes*; and have alſo ſuppoſed him to traverſe the *Syſtem*, and to have actually taken thoſe ſeveral *Meaſures* and *Dimenſions*, and noted them down in a Table.

Next, I have directed him how to delineate theſe Obſervations, and afterwards to fit up his Projection into a *Curious Aſtronomical Inſtrument*, by which he may eaſily calculate, at all Times, the Places of all the *Primary Planets*, and exhibit their Situations as naturally as in the Heavens themſelves.

To

To make it ſtill more evident, I have annexed a Variety of *Examples*—ſome for each Planet; which, being once peruſed, he cannot fail of underſtanding the uſual Method of making theſe Calculations by *Triangles*, as he will immediately ſee on the *Inſtrument* how the Lines are ſituate in the Heavens;——what *Sides* and *Angles* are given, and what required to be found by *Trigonometrical Calculation.*

He has in the laſt Place, a new *Sett of Tables* for finding the *mean Anomalies*, and Equation Tables for each Planet, for reducing them to the *true Anomalies.*——Alſo, a *Table* is added of *Inclinations*, or *Heliocentric* Latitudes of the Planets, depending on their Diſtances from their *Nodes*: And to make the Work more complete—*all theſe Tables are adjuſted to the* NEW STYLE.

That the Youth may receive that *Pleaſure* and *Advantage* from the Peruſal of this *Work* which was intended them by its Publication, is the ſincere Wiſh of

The AUTHOR.

THE HEAVENS SURVEYED.

AS Nothing can give us higher, or more noble *Ideas* of GOD, the great Former of the Univerſe, than — to contemplate the Planetary Worlds above;—to ſurvey the aſtoniſhing Spaces through which they rowl;—to reflect on the Vaſtneſs of their Bulks;—the amazing Velocity of their Motions;—and above all, the exact Regularity and Harmony of their Periods:—ſo I flatter myſelf, that any rational Scheme tendered to the World, with a Deſign of facilitating Enquiries of ſuch a ſublime and intereſting Nature, cannot but be pleaſing to every thoughtful and ingenuous Mind.

And, though it be very poſſible to give the Learner a Knowledge of the Wonders and Immenſity of that Heavenly Fabric from this Earth on which he now reſides; yet as it would be more eaſy and natural for him to behold it from the *Center*, round which all the Planets move, he will give me Leave to conduct him thither, and point out to him the wonderful Conſtruction and *Phænomena* of the Syſtem from that Point of View *.

* As the young Aſtronomer hath pointed out to him here, the Order and Harmony of the Syſtem from the *Sun*, the Center of it; ſo at Page the 24th, the Diverſity of the Motions and Aſpects of the ſeveral Planets are exhibited to him from the *Earth*, the Place of his preſent Reſidence.

On his Arrival *there*, he will find the *Sun*, an huge Globe of Light, plac'd in the Midſt of immenſe Space, with Six opaque ſpherical Bodies moving round him as their Center; which at different Diſtances, and in different Periods of Time, perform their Revolutions all the ſame Way, *i.e.* towards the *Left-hand*, in the Order following.

Firſt, he will ſee *Mercury* the neareſt of all the *Planets*, moving the quickeſt, and deſcribing the ſmalleſt Orbit round the *Sun*.——Next, he will ſee *Venus*, which, as ſhe is further off, takes a larger Circuit, and a longer Time to compleat it.——Beyond her he will behold our *Earth* moving in her Orb not quite ſo faſt as *Venus*.——Next her advances *Mars*, but revolves much ſlower.——Then comes, at a vaſt Diſtance beyond him, the Planet *Jupiter*, ſlower ſtill.——And laſt of all, he ſees *Saturn*, as it were come *creeping* round his Orb *.

At a vaſt Diſtance beyond *Saturn*, he will obſerve the azure Sphere of the *fixed Stars*, ſparkling all over with Lights of different Luſtres and Magnitudes. Theſe he will find, (contrary to the Planets) never to vary their Places, but remain always in the ſame Poſition. And as it is impoſſible to diſtinguiſh each ſingle Star by a particular Name, *Aſtronomers* have agreed to ſuppoſe a Number of them lying near each other, to be covered with the Image or Picture of ſome Animal, or other Thing.—That *Round* of the *ſtarry Arch* oppoſite to the Orbs of the *Planets*, is divided into 12 Images, whoſe Names are, *Aries*—*Taurus*—*Gemini*—*Cancer*—*Leo*—*Virgo*—*Libra*—*Scorpio*—*Sagitarius*—*Capricornus*—*Aquarius*—*Piſces*. This Space is called the *Zodiac*. It is ſuppoſed to be divided into 360 equal Parts, called Degrees: *Thirty* of which belong to each Image.

☞ The Earth's Orbit paſſes exactly oppoſite the Middle of theſe 12 Signs or Pictures.—And a Plane level with the Earth's Orbit extended from the Sun to the fixed Stars is called the *Plane of the Ecliptic*†: and this Aſtronomers make the ſtandard to which the Planes of the other Planets (which is very little) are found to incline.

* Beſides theſe ſix *Primary* Planets, which continually circulate round the *Sun* as the Center of their Motion, there are ſeveral *Smaller* which circulate round them, and are carried with them in their Journeys round their Orbits. Theſe are called *Satellites*, or *Moons*, and are *ten* in Number: of which *one* well known, belongs to our *Earth*. *Four* attend *Jupiter*; and *five* wait upon *Saturn*, who has alſo a bright *Ring* ſurrounding his Body edge-wiſe, but no where touches it. Theſe *Moons* (which are a *Secondary kind of Planets*) are too *ſmall* to be ſeen by an Aſtronomer at the *Sun*, or even at the *Earth* when it is much nearer them—without a *Teleſcope*. The *Tracts* too, which they deſcribe in the Heavens, are very complicated; ſome forming *Curves* with *Loops* in them; and others *Lines* difficult for a Learner to conceive immediately; for which Reaſon I have reſerved the *Theory* of their Revolutions and Method of calculating their Poſitions, with reſpect to their *Primaries*, for a future Part of this Work.

† Becauſe no Planets are *eclipſed*, or hid by one another from the Sun, but when they are in that *Plane*, and exactly in the ſame Line continued to the Stars.

The

The ſeveral *Periods* of the Planets round the *Sun*, if accurately obſerved, and reduced to our *Time* here, as they depart from any *fixed Star* and return to it again, will be found nearly as under.

			Days		Hours		Min.	
Mercury	revolves about the *Sun* in the Space of		87	-	23	-	16	which is the Length of the *Year* at that Planet:
Venus			224	-	16	-	49	
Earth			365	-	6	-	9	
Mars			686	-	23	-	27	
Jupiter			4332	-	12	-	20	
Saturn			10759	-	6	-	36	

☞ *Mercury* and *Venus* are called *inferior Planets*, becauſe they are lower or nearer the Sun than the Earth is; but *Mars*, *Jupiter*, and *Saturn* are called *ſuperior Planets*, becauſe they move beyond the Earth, and are higher in the Syſtem.

The *Planets* he will obſerve to revolve the ſame Way, and nearly round the middle or *equatorial* Parts of the *Sun*, with a very ſmall *Inclination* to one another. For if he makes the Earth's Orbit the Standard of the other Orbits, he will obſerve that they have one Half a little *above*, and the other Half a little below it, cutting it in two oppoſite Parts exactly.—The *Inclinations* of theſe Orbits to the Plane of the *Earth's Orbit* he will find to be nearly thus.

			Deg.		Min.
The Orbit of	Mercury	inclines to the Earth's Orbit, or makes an Angle with it of about	6	-	54
	Venus		3	-	23
	Earth		—	-	—
	Mars		1	-	51
	Jupiter		1	-	22
	Saturn		2	-	30

The Points where the ſeveral Orbits of the Planets cut or croſs the Plane of the Earth's Orbit, either in aſcending above it, or deſcending below it, are called the *Nodes* of thoſe Planets.--That Point where the Planet aſcends above the Orbit of the Earth is called the *North* or *Aſcending Node*; and the other Point where the Planet deſcends below it, is called the *Southern* or *Deſcending Node*.—Theſe *Nodes* or apparent *Interſections* of the Orbits of the *Planets* with that of the *Earth*'s Orb, (if referred to the *Ecliptic* at the Stars) will be found at this Time to be nearly in the following Places.

			Deg.		Min.	
The North or Aſcending Node of	Mercury	is in	15	-	45	Taurus
	Venus		14	-	34	Gemini
	Earth		—	-	—	———
	Mars		18	-	9	Taurus
	Jupiter		8	-	32	Cancer
	Saturn		21	-	26	Cancer

☞ The *South* or *Deſcending Node* is in the Sign, Degree, and Minute oppoſite the aſcending one.

Whilſt

Whilſt the Obſerver views the ſeveral *Planets* revolving round the Sun in their annual Courſes, he will perceive that each has a Rotation upon its own Axis, to cauſe *Day* and *Night* at that Planet.—The Times of their ſeveral Rotations are as follow.

		D.	H.	Min.	
Mercury	turns upon its Axis in about	0	6	0	which is the Length of the *Day* to the Inhabitants there.
Venus		0	23	0	
Earth		0	23	56	
Mars		1	0	40	
Jupiter		0	9	56	
Saturn		29	10	1	

☞ The Earth turns upon her Axis in reſpect to the *fixed Stars* in 23 Hours 56 Minutes, but in reſpect to the *Sun* in 24 Hours *.

The *Axis* of every *Planet* he will obſerve to lean or incline to the Plane of its own Orbit, from whence will neceſſarily ariſe a Variety of Seaſons in thoſe Planets. The *Axes* of the *Planets* always keep in the ſame Poſition † or Parallel round their Orbits. Their *Inclinations* are as here ſet down.

		Deg.	Min.
Mercury's	Axis inclines to the Plane of its Orbit	—	—
Venus's		very little	
Earth's		23	29
Mars's		very little	
Jupiter's		very little	
Saturn's		30	0

The *Velocities* of the *Planets*, or Spaces of their Orbs paſſed thro' in a given Time, he will diſcover to be *greater* in the Planets nearer the *Sun*, and *leſs* in thoſe further off. Their Motions in an Hour are as here expreſſed.

		Miles.	
Mercury	moves in *one Hour* about	100.000	and ſo far are the Inhabitants of that Planet carried every *Hour*, without being ſenſible of that rapid Motion.
Venus		70.000	
Earth		56.000	
Mars		45.000	
Jupiter		24.000	
Saturn		18.000	

From a late Obſervation, if it may be depended on, the *Velocities* of the Planets are one ſixth Part greater ſtill.

* The Rotations of *Mercury* and *Saturn* upon their Axes were obſerved by the Aſtronomer *Rheita*; and *Bianchini* makes the Rotation of *Venus* to be $24^d\ 8^h$, and the *Inclination* of her Axis 75°.

† See my Modern *Geography* or Modern *Aſtronomy*, where the Earth, with the proper Inclination of its *Axis*, is delineated in four various Parts of its Orbit.

The

The Spectator, whilſt he continues at the *Sun*, will further obſerve that the Planets in their Revolutions, when they arrive to a certain Part of their Orbits will appear a little larger, and when they come to the oppoſite Part will appear a little ſmaller. He will alſo perceive that when they look ſmaller their Motion is ſomething ſlower; but as they begin to appear bigger their Motion grows a little ſwifter. Hence he will be naturally led to infer, that they muſt ſometimes be a little nearer to him, and at other Times a little further from him; and, conſequently, that their Orbits cannot be *perfectly circular*, but a little *elliptical*, or *oval*.—When any Planet is at its greateſt Diſtance, it is ſaid to be in *Aphelion* (or from the Sun); when at its leaſt Diſtance, it is ſaid to be in *Perihelion* (or near the Sun)*.——The exact Places in their Orbits where the ſeveral Planets are in their *Aphelions*, or greateſt Diſtances from the *Sun*, the Obſerver will find, at this Time, to be when they appear againſt, or in the following *Signs* and *Degrees* of the *Ecliptic*.

			Deg.		Min.
Mercury's	*Aphelion Point* is in or about	Sagitarius	13	-	45
Venus's		Aquarius	7	-	37
Earth's		Capricorn	8	-	57
Mars's		Virgo	1	-	55
Jupiter's		Libra	10	-	58
Saturn's		Capricorn	0	-	6

Their *Perihelion Points* are in the oppoſite *Sign*, *Degree*, and *Minute*, exactly.

Now, if the Obſerver be ſuppoſed to advance from the *Sun* to each Planet when in *Aphelion*, and again when in *Perihelion*, and accurately meaſure their ſeveral Diſtances from the *Sun* to thoſe Points of their Orbits, he will find them to be nearly as under†.

Mercury's	Aphelion, or greateſt Diſtance from the Sun	38.455.700	Perihelion, or leaſt Diſtance from the Sun	25.544.300
Venus's		59.418.770		58.581.230
Earth's		82.368.900		79.631.100
Mars's		134.421.000		111.579.000
Jupiter's		444.290.500		403.709.500
Saturn's		821.307.000		732.693.000

* At the *Sun*, the Planets appear but ſmall: for *Mercury*'s diameter does not ſubtend an Angle of more than 20″; nor *Venus*'s of more than 30″ The *Earth* appears nearly the ſame as Venus *Mars*'s Diameter appears about 5″. *Jupiter*'s about 40″; and *Saturn*'s about 20″. The *Satellites* or *Moons* of Jupiter and Saturn, are not viſible there.

† An Obſerver of the Planets *there*, might gain ſome Idea of their *relative Diſtances* and *Magnitudes*, but could not obtain their real Ones; becauſe no Method offers itſelf at that Station of aſcertaining their *Parallax*: Nay, the Planets ſeen from thence have *no Parallax* at all.

When the *Planets* are in the Middle of their Orbs, between the *Aphelion* and *Peribelion* Points,—they are ſaid to be at a *mean Diſtance* from the *Sun*: which Diſtances of all the Planets will be found nearly theſe following.

Mercury's	Mean or Middle Diſtance from the Sun is about	32	Millions of Miles.
Venus's		59	
Earth's		81	
Mars's		123	
Jupiter's		424	
Saturn's		777	

The Diſtance of the neareſt of the *fixed Stars* he will find to be almoſt 20 Millions of Millions of Miles from the *Sun*, which is more than 20.000 Times farther than *Saturn**.

If the *Diameters* of the *Planets* be taken by the Surveyor as he paſſes along in meaſuring the Diſtances, they will be found to be nearly as under.

The Sun's	Diameter is about	763.000	Miles.
Mercury's		2.460	
Venus's		7.906	
Earth's		7.964	
Mars's		4.444	
Jupiter's		81.155	
Saturn's		67.870	

☞ The Diameters multiplied by 3.141 will give their *Circumferences*.

At the different *Planets* he will obſerve the *Sun* of different Magnitudes; bigger to the neareſt, and leſs to thoſe farther off. The Solar *Light* is alſo much greater to the nearer Planets than to thoſe ſituate higher in the Syſtem.

At Mercury	the Sun's *Diameter* appears almoſt	2 Feet ¾	and the *Light* there is about	7 Times greater than at the *Earth*.
At Venus		1 Foot ½		Twice as great
At Earth		1 Foot		
At Mars		9 Inches		Half as great
At Jupiter		2 Inches ¼		27 Times leſs
At Saturn		1 Inch ¼		90 Times leſs

At the *fixed Stars* the *Solar Diſk* dwindles into a lucid *Point*, and ſeems only a Star in the oppoſite Part of Heaven; and all our Planets are totally inviſible there.

☞ The *fixed Stars*, in all Probability, are ſo many Suns, having Planets ſurrounding them, as our Sun has.

As the *young Aſtronomer* traverſes the Syſtem, he will obſerve that all the Planets caſt a *Shadow* behind them directly oppoſite the Sun, which Shadow terminates in a Point before it reaches the Orbit of its ſurrounding Planet: But the *Moon* revolving round our *Earth*, and thoſe of *Jupiter* and *Saturn*, he will find to run ſometimes into the Shadows of their Planets, and by that means be deprived of the Sun's Light. At that Time they become obſcure, and are ſaid to ſuffer an Eclipſe.

The Nature of *Eclipſes* of the *Earth* and *Moon* are fully explained in the *Syſtem of Modern Aſtronomy*.

* Theſe are the Diſtances of the Planets uſually received by Aſtronomers; but if the late *Tranſits of Venus* over the *Sun* may be depended on, the Diſtances will be found to be about *one ſixth Part greater*; that is, thoſe will exceed theſe about as much as *Statute* Miles exceed *Computed* Miles: But Projections of the Syſtem made from either Meaſure will be equally exact. The Method of calculating the Diſtances both Ways may be ſeen in my *Trigonometry*.

The

The *Sun* he will diſcover to be a huge Sphere, of moſt wonderful and exquiſite Conſtruction, which, by repeated Circumgyrations on its Axis, projects from its Surface fine ſubtile Particles of Matter (uſually called *Æther*) to the moſt diſtant Parts of the Univerſe.——Theſe Particles by their amazing Velocity conſtitute not only our *Light*, but are perhaps the *Primum Mobile*,—the Spring of Motion and Action of the whole Syſtem. Their Motion is inconceivably rapid, being not leſs than 10 Millions of Miles *per Minute*; ſo that they reach *Mercury* in 3′, *Venus* in 5′, the *Earth* in 8′, *Mars* in 12′, *Jupiter* in 42′, *Saturn* in 77′;—but do not arrive at the *neareſt fixed Star* in leſs than 3 or 4 Years, and to Stars of the *ſecond* Magnitude not in leſs than 6 or 7 Years: And ſo long is Light deſcending from thoſe Stars to us.——Hence we may reflect how very different the Places of the *Sun*, *Planets*, and *fixed Stars* are in the Heavens, from thoſe they appear in from hence.

The Obſerver, as he leaves the Regions of the Sun and advances toward the Planets, will behold the whole Space he paſſes through to be *obſcure* and *duſky*, unleſs the aforeſaid revolving Bodies, which appear very bright, by reflecting the *Solar Light* back to his Eye.—He will alſo perceive it grow very *cold* as he recedes from the Sun, becauſe the Light is ſo ſubtile as to pervade and paſs thro' him with little or no Reſiſtance: But as he enters the *Atmoſphere* of any Planet, and becomes inveſted with the groſſer Parts of it, he will find it begin to grow *warm*, which Warmth will continue to encreaſe upon him, till he comes down to the Surface of the Planet, where he will experience the greateſt Heat of all.

The *Heat* and *Cold* at any Planet he will diſcover to ariſe—not ſo much from the Planet's Nearneſs to or Diſtance from the *Sun*, as from the Nature of its *Soil* and the Denſity of its *Atmoſphere*.—Hence it happens that, by the Rarity of it at *Mercury*, and the Denſity of it at *Saturn*, the Inhabitants of the former do not complain of the *Intenſity* of the *Heat*, nor thoſe at the latter lament the *Severity* of their *Cold*; but as regular Temperament is obſerved and kept up at each Planet as upon the Earth where we live. This makes them *all* fit Places for Habitation, and as comfortable and agreeable in their Variety of Seaſons, of *Days*, and *Years*, as ours here.

Beſides theſe Wonders of the Heavens, there are many others not yet come to his Inſpection*.—To ſurvey them *all* would be a Work next to impoſſible; ſince they are like the *Divine Contriver*, infinite perhaps, and, at preſent, paſt our finding out. But theſe, already beheld and diſcovered, are enough to convince us, not only of the *Exiſtence* of GOD, but alſo, of his *Wiſdom*, *Power*, and *Goodneſs*; and to make us break out and confeſs, in the Language of the Pſalmiſt, that———*There is no Work like thy Work—for thou art great and doeſt wonderful Things!*

* As (1) What the Power is, which retains the Planets in their Orbits; and keeps the Inhabitants upon their Surfaces as they rowl round their *Axes*. (2) What the Cauſes of thoſe Laws are by which that Power acts through all Parts of the Syſtem. (3) Whether the ſame Number of Revolutions of a Planet does not determine the Age of the Inhabitants there. (4) Whether thoſe that live at *Mercury* are not 4 Times more active than we at the *Earth*; and whether our Ideas and Actions here are not 30 Times quicker than their's at *Saturn*. (5) Whether a Child born at the ſame Moment on each Planet,—that at *Mercury* will not be 4 Years old (of our Time);—that at *Venus* 1 Year 8 Months;—that at *Mars* Half a Year;—that at *Jupiter* 1 Month;—that at *Saturn* only 12 Days, when that upon our *Earth* ſhall have compleated 1 Year. Theſe, with Obſervations relative to the Dimenſions of the Inhabitants of each Planet, may be conſidered in a future Work.

Here

Here follows A TABLE, in which the foregoing *Proportions* and *Properties* of the *Primary* PLANETS are brought to one View.

Planets Names. Their *Revolutions.*	Mercury. $87^d\ 23^h\ 16'$	Venus. $224^d\ 16^h\ 49'$	Earth. $365^d\ 6^h\ 9'$	Mars. $686^d\ 23^h\ 27'$	Jupiter. $4332^d\ 12^h\ 20'$	Saturn $10759^d\ 6^h\ 26'$
Inclination of their Orbits to Earth's.	6° 54′	3° 24′	the Standard	1° 52′	1° 20′	2° 30′
Place of the *Ascending Node*, the *Descending* oppoſite.	♉ 15° 45′	♊ 14° 34′	* * *	♉ 18° 9′	♋ 8° 32′	♋ 21° 26′
Turn upon their *Axes*.	$0^d\ 6^h\ 0'$	$0^d\ 23^h\ 0'$	$0^d\ 23^h\ 56'$	$1^d\ 0^h\ 40'$	$0^d\ 9^h\ 56'$	$29^d\ 10^h\ 1'$
Inclination of their *Axes* to their *Orbits*	* * *	very little†	23° 29′	very little	very little	30° 0′
Place of the *Aphelions*, the *Perihelions* oppoſite.	♐ 13° 45′	♒ 7° 37′	♑ 8° 57′	♍ 1° 55′	♎ 10° 58′	♑ 0° 6′
Greateſt *Diſtance* from the Sun.	38.455.700	59.418.770	82.368.900	134.421.000	444.290.500	821.307.000
Leaſt *Diſtance* from the Sun.	25.544.300	58.581.230	79.631.100	111.579.000	403.709.500	732.693.000
Mean *Diſtance*.	32.000.000	59.000.000	81.000.000	123.000.000	424.000.000	777.000.000
Their *Diameters* in Miles.	2.460 *	7.906	7.964	4.444	81.155	67.870
Motion in 1 Hour.	100.000	70.000	56.000	45.000	24.000	18.000
Proportion of *Light* and *Heat*.	7 Times greater.	2 Times greater.	at the Earth 1	½ as much	27 Times leſs.	90 Times leſs.

The *mean Diſtances* of the Planets from the Sun, their *Diameters*, and *hourly Motion* in their Orbits, as deduced from the late *Tranſit of Venus* over the Solar Diſk, are as under; and are about one fifth greater than thoſe uſually received.

New Diſtances.	36.841.468	68.891.486	95.173.000	145.014.148	494.990.970	907.956.130
Diameters.	3.100	9.360	☉ 843.760 ⊖ 7.970	5.150	94.100	77.990
Motion in 1 Hour.	109.699	80.295	68.243	55.289	29.083	22.101

The Diſtance of the neareſt *fixed Star* is almoſt 20 Millions of Millions of Miles from the Sun; which is above 20.000 Times farther than *Saturn*. Stars of the 2d Size are almoſt as far again.

The Obſerver in his *Tour* thro' the *Syſtem* having made theſe Obſervations, and taken theſe Dimenſions, and noted them down in a Table, as a Surveyor does the Angles and Sides of a Piece of Land in his Field-book, he may proceed to delineate the Survey in the following Manner.

† *Bianchini* ſuppoſes the Axis of *Venus* to incline 75 Degrees; that ſhe revolves on her Axis in 24 Days 8 Hours; conſequently has only 9 Days and ¼ in her Year.

* The *Light* and *Heat* at the *Sun* is about 45.000 Times greater than at the *Earth*.—His Diameter is 763.000 Miles.—The Inclination of his Axis about 8 Degrees, and his Revolution round it is performed in 25 Days and ¼.

A

DELINEATION of the HEAVENS,

ACCORDING TO

The foregoing SURVEY.

☞ THIS Delineation will conſiſt of two Parts, a *ſmaller* and a *larger*; (ſee the two Plates at the Beginning of the Book)—The ſmaller Part has ſeveral Circles deſcribed upon it.——The *Center* repreſents the *Sun*.—The firſt Circle next him, the Orb of *Mercury*;—the ſecond, *Venus*;—third, our *Earth*;—fourth, *Mars*;—fifth, *Jupiter*;—ſixth, *Saturn*;—and the next Circle (which is double) beyond *Saturn*, repreſents the *Ecliptic Line* at the *fixed Stars*, divided into the 12 Signs;—and the Circle bounding it is alſo divided into 12 Signs, and on this is accounted the *Earth's Anomaly*.——On the other, or larger Part, is deſcribed another double Circle, which is divided into 12 Signs. This Circle is uſed in reckoning the *Anomaly* of any of the Planets.——This being premiſed, the Reader may proceed to the *Conſtruction* or *Delineation* as follows.

Firſt, make a *Scale* of *equal Parts*, of any Size you pleaſe;—then taking off about 850 of thoſe Parts, deſcribe the *Ecliptic Line*, and divide it into 12 equal Parts, and each Part into 30 more; write therein the *Names* of the *Signs* and their *Characters*, as you ſee in the ſmaller Plate.——Then you may proceed to delineate the Orbs of the *Planets* in the following Manner.—— Look in the Table before-going, for the *Aphelion* Place (firſt for *Saturn*) and you will find it to be at 0° 6′ of *Capricorn*.—Find this Place on the *Ecliptic*, and draw a Line from it (with a Black-lead Pencil) through the Center to the oppoſite Sign and Degree.—Then look alſo, in the ſame Table, for the *greateſt Diſtance* of *Saturn*, which take off the ſame Scale of equal Parts, and ſet it from the Center towards the *Aphelion* Point, where make a Dot, and write *Aphelion*.—Take alſo the *leaſt Diſtance* off the Scale, and ſet it from the Center towards the *Perihelion* Point, and there make another Dot, and write *Perihelion*.—Then finding the *Middle*, between thoſe Diſtances, deſcribe thereon a Circle, which will expreſs the *Orbit of Saturn*.—In the Table look the Place of *Saturn's Node*, and having found it in your *Ecliptic*, lay a Ruler from the Center to that

Part, and where it interſects (or cuts) the Orb of Saturn make a Dot, and inſcribe againſt it N. ☊ for *North Node*. In the oppoſite Part of the Orbit make another Dot, and inſert there S. ☊ for *South Node*.——In the ſame Manner you may proceed to project the *Orbs*, with the *Aphelions*, *Perihelions*, and *Nodes* of all the *primary Planets*: which being performed, you muſt then deſcribe a Circle a little beyond the *Ecliptic*, and right againſt the *Aphelion Point* of the *Earth* begin to divide it into 12 Signs and Degrees, as the *Ecliptic* is; and number it as you ſee done there.——On this Line is always found the *Earth's Anomaly*.

Next, upon the *larger Part*, deſcribe another Circle, ſomething wider than that of the *Earth's Anomaly*, and, beginning at any Part, proceed to divide it in every reſpect as the *Earth's* is.——On this Circle the *Anomaly* of the *Planets* is always found.

Laſtly, take the larger Part, cut it round cloſe to the Circle, and paſte it upon a ſtrong circular Board of the ſame Size: This Board ſhould have three ſmall Feet on the under Side, about two Inches high, to raiſe it free from the Table it ſhall be placed on when uſed.—The ſmaller Part muſt in like Manner be cut round, and paſted upon a very thin Piece of Board (that will not warp) which juſt fits it. Then the Centers of both Parts are to be connected by a large Pin or Wire, in ſuch Manner, that the upper Part may turn eaſily upon the under.

To the Pin, which ſtands about one Inch high, are to be fixed three *fine Threads*, with a ſmall Plummet or Ball at the End of each, to keep them ſtrait when extended from the Center; and a ſmall Bead may alſo be put upon each Thread.—Upon the *Top* of the *Pin* may be affixed a large *Bead*, which will ſerve as well for Ornament, as repreſent the *Sun* in the Center of all the Planets.

Thus is the Projection finiſhed, repreſenting the true Proportion and Symmetry of the Heavens; and becomes, thus fitted up, a *curious Aſtronomical Inſtrument*, by which the Places and Situation of all the Planetary Worlds, with reſpect to one another, may be determined at any Time, with great Exactneſs and little Trouble.

Some of the many Uſes of this Inſtrument immediately follow

THE

THE USE OF THIS Cæleſtial PROJECTION or INSTRUMENT.

I. To *Rectify* the *Inſtrument*.

FIRST, bring the *Aphelion Point* of the Planet, whoſe Place you want to find in the Heavens, on the moveable Part, to the Beginning of the Diviſions on the Circle in the fixed Part, and let it remain there.

II. To find the *Anomalies* of any of the *Planets*.

Turn to the *Tables* at the End of the Book, and write out the *Anomalies* of the *Earth* and of the *Planet*, anſwering to the *Year*, *Month*, *Day*, and *Hour* propoſed. Theſe added up ſeverally will be the *mean Anomalies* * of each for that Time, remembering in *Leap Year*, after *February*, to add the Motion of one Day more.

With theſe *mean Anomalies* enter the *Tables* of their *Equations*, with the *Sign* at the *Top* (if leſs than ſix Signs), and the *Degree* in the firſt Column on the left Hand deſcending:——But if the *Anomaly* be ſix *Signs* or more, look the *Sign* at the *Bottom* of the Table, and the *Degree* on the right Hand *aſcending*; and in the common Angle, or Place of Meeting, is the Equation; which, according to the Title, *added* to, or *ſubtracted* from the *mean Anomaly*, will give the *true Anomaly*, or real Diſtance of the Earth and Planet from their Aphelions at that Time.

III. To find the *Heliocentric Place* of any of the *Planets*.

Lay one of the Threads upon the *Anomaly* of the *Planet* found in the *outer Circle*; and alſo a Thread to the *Anomaly* of the *Earth* found in the *ſecond Circle*, ſo will theſe Threads ſeverally cut the *Heliocentric Places* of the *Earth* and *Planet* (*i. e.* the Places as ſeen from the *Sun* the Center of the Syſtem) in the *Ecliptic*; and the Places where the Threads cut their Orbits will be the *true Places* of thoſe two Bodies, and the exact Situation of them in the Heavens at that Time. And if a ſmall *Bead*, which ſhould be upon each Thread, be brought to each of theſe Interſections, they will truly repreſent the Planets themſelves.

* The *mean Anomaly* of a Planet is its Diſtance from the *Aphelion* Point, ſuppoſing the Orb in which it revolves to be *circular*. But its *true Anomaly* is its Diſtance according to an *Ellipſis*, which is the true Figure (more or leſs) of all their Orbits.

IV. To find the *Geocentric Place* of any *Planet*, *i. e.* its Place in the *Ecliptic* as ſeen from the *Earth*.

Lay the Edge of the Scale, or Index, you projected the Inſtrument by, from the *Earth* in its Orb to the *Planet* in his; then bring the third Thread ſo as to lie *parallel* to the Index; remembering to lay it ever from the Center towards the Planet; ſo will the Thread cut the *Ecliptic* in the Planet's *Geocentric Place*, and ſhew the Sign, Degree, and Minute of the Ecliptic it then poſſeſſes as ſeen from *hence* *.

V. To find the *Heliocentric Latitude* of a *Planet*, *i. e.* its Latitude as ſeen from the *Sun*.

At the ſame Time as the Bead lies upon the Orbit of the Planet, you may eaſily diſcover his Diſtance from the *neareſt Node*; and by knowing the Planet's greateſt Latitude, or Inclination, (which is always when he is in the *middle*, between the *Nodes*, and is expreſt in the foregoing Table) you may nearly eſtimate his Latitude at that Time.

If the Bead or Thread lie on the right Hand the *N. Node*, the Planet has North Latitude; and lies *above* the Plane of the Earth's Orbit, ſo much as is his Latitude:—If the Thread lie on the right Hand of the *S. Node*, the Planet has South Latitude; and is *below* the Ecliptic, or Plane of the Earth's Orbit.

☞ But to diſcover the *Latitude* more exact; count the Planet's Diſtance from the *neareſt Node* in *Degrees*; with that Diſtance enter the Table of *Inclinations*, &c. at the End of the Book; and right againſt it, under the Planet, you have the Planet's *true Heliocentric Latitude* at that Time.

* The Orb of the *fixed Stars* being delineated near to the Orbit of *Saturn*, whereas it ſhould have been placed (had there been Room) above 20.000 Times further off, the *Index* when laid from the *Earth* to the *Planet*, cannot cut the *Ecliptic* in the Place it would do if it was removed to its true Diſtance. —— But as the Diſtance of the *Stars* is ſo immenſely great, the *Semidiameter* of the *Earth*'s Orbit dwindles as it were into a *Point*, conſequently, a *Line* extended from the *Sun*, *parallel* to the *Index*, will fall upon the ſame Point or Part of the *Ecliptic* that the *Index* would do, if extended thither.

VI. To

VI. To find the *Geocentric Latitude* of a *Planet*, *i. e.* his *Latitude* as ſeen from the *Earth*.

The *Latitude* of a Planet as ſeen from the *Sun*, is very different from that ſeen from the *Earth*; becauſe the Earth in moving round her Orbit muſt be ſometimes nearer, ſometimes farther off the Planet, than the Sun is: But having found the Latitude as ſeen from the Sun (by the former Propoſition), you may find his Latitude as ſeen from the Earth in the following Manner.

——Meaſure with the *Index* the *Planet*'s Diſtance (in Millions of Miles) from the *Sun* and from the *Earth*; then ſay by the Rule of Three *Inverſe*,

As the Planet's Diſtance from the *Sun*,
Is to his Latitude ſeen from thence;
So is his Diſtance from the *Earth*,
To his Latitude ſeen at the Earth.

Hence it always follows, that when the Earth is nearer the Planet than the Sun is, the *Geocentric Latitude* will be greater than the *Heliocentric*: But when the Earth is farther off than the Sun from the Planet, the *Geocentric Latitude* will be leſs than the *Heliocentric*.

VII. To find when any of the Primary *Planets* are in *Aphelion* or *Perihelion*.

Having collected from the Tables the *Anomalies* for the Time propoſed, if the Sum amount to o Sign, o Deg. *&c.* the Planet is then in *Aphelion*, or at its greateſt Diſtance from the Sun, and its Motion is then ſloweſt: But if the Sum be exactly 6 Signs, it is then in *Perihelion*; is neareſt the Sun, and its Motion is now at the faſteſt.

☞ This is ſeen immediately upon the Inſtrument.

VIII. To find when a *Planet* is in *Apogeon* or *Perigeon*.

If the Threads when laid--the one to the *Earth*'s *Anomaly*, and the other to the *Planet*'s *Anomaly*, lie in a right Line on *different Sides the Sun*,—the Planet is then in *Apogeon*, or at his *greateſt* Diſtance from the *Earth*:---But if the Threads lie one upon another, on the *ſame Side the Sun*, the Planet is then in *Perigeon*, or *neareſt* the *Earth*.

IX. To find when a *Planet* is at its greateſt *Elongation*, or Digreſſion from the *Sun*, on either Side of him.

In the Superior Planets, *Saturn*, *Jupiter*, and *Mars*, this is always when they are *oppoſite* the *Sun*, or 180 Degrees diſtant from the Sign and Degree he is then in.——But in the Inferior Planets, *Venus* and *Mercury*, it is when the *Index* being laid from the Earth to the Planet does no where cut the Planet's Orbit, but exactly touches it, like a *Tangent Line*.

X. To know when a *Planet* is *Direct*, *Stationary*, or *Retrograde* in the Heavens.

(1.) For the *Superior Planets*.

When the Index is laid from the *Earth's* Place in her Orbit, to *Saturn*, *Jupiter*, or *Mars* in their's, if the Index does not cut the *Earth's Orbit*, but becomes a *Tangent Line* to it, then the Earth is at its *greateſt Elongation* ſeen from that Planet; and the Planet, about that Time, ſeen from the Earth, becomes *ſtationary*. And if the Earth be advancing towards the Planet on the ſame Side with the Planet, it is then *ſtationary to Retrogradation*; which *Retrogradation* will become viſible in a few Days, and continue all the Time the Earth is on the *ſame Side with the Planet*.——And when the Index becomes a *Tangent* to the Earth's Orbit on the other Side, the Planet becomes *ſtationary to Direction*; which *Direction* of the Planet will take Place in a few Days, and continue all the Time the Earth is on the *oppoſite Side the Sun*.

(2.) For the *Inferior Planets*.

If the Index when laid from the *Earth* to either of the Inferior Planets, *Venus* or *Mercury*, does not cut their Orbit, but touch it only, then you are certain that the Planet is at its *greateſt Elongation*, and *ſtationary* at that Time; and, if it lie on the right Hand the Sun, it is *ſtationary to Direction*----if on the left Hand, it is *ſtationary to Retrogradation*. But if the Index fall within the Orbit, the Planet is (if beyond the Sun) *direct* in Motion: But if on the ſame Side the Sun with the Earth, it is going *retrograde* in that Appearance.

☞ This Rule would hold exactly true, if the *Earth* were at reſt in her Orbit: But as ſhe advances at the ſame Time the ſame Way with the *Planet*, theſe *Stations* and *Retrogradations* will happen *later* on the *left Hand*, and *ſooner* on the *right Hand*; the former ariſing from the *Difference* of their Motions; the latter from the *Sum*: For which Reaſon the following will be more exact.——Obſerve the *Angle* made at the *Sun* by the two Threads, and if it be

Deg.			
66	between the Earth and	Saturn	That Planet is *ſtationary to Retrogradation*, if on the *left Hand* Side the Earth; or *ſtationary to Direction*, if on the *right Hand* Side.--If the *Angle* be leſs, the Planet is *retrograde*; if bigger, it is *direct* in Motion.
53½		Jupiter	
22½		Mars	
15		Venus	
32		Mercury	

XI. To

XI. To discover when any of the *primary Planets* shine in the Morning or Evening; that is, when they are *Morning* and *Evening Stars*.

Bring the Earth's Place in her Orbit so as to lie towards you; and lay the Index across the Instrument from the Earth through the Sun; then all those Planets on the *left Hand* Side of the Index are *occident*,* or *eastward* of the Sun ---shine in the *Evening*, and set after him.——But all those Planets on the *right Hand* Side are *orient*,† or *westward* of the Sun, and shine in the *Morning* before the Sun rises.

☞ If a Planet be not farther from the Sun than 12 or 13 Degrees, either before or after him, it will not be visible in the Morning or Evening, by reason of the *Sun*'s superior Light.

XII. To know when either of the *Inferior Planets*, *Venus* or *Mercury*, will *transit* the *Sun*, or appear as a Spot upon his Face.

If the Threads, when laid to the *Anomalies* of the *Earth* and *Venus* or *Mercury*, happen to coincide, or lie upon one another, then the inferior Planet must lie exactly between the *Earth* and the *Sun*; and if this happen at, or very near the Node of the Planet, it may be seen (with a common Telescope) to pass over the Sun's Face, making a black Spot upon his Disk. But if the Planet be not within a few Degrees of either Node, it will then pass under or over the *Sun*, just as it has *North* or *South Latitude* at that Time.

This being premised, we will proceed to illustrate all with an *Example* in each *Planet*.

* A Planet is said to be *Occident*, when it is more towards the East than the Sun; because it is then seen in the *occidental*, or western Part of the Horizon after the Sun is set.

† A Planet is said to be *Orient*, when it is nearer to the West than the Sun; because it appears then in the *oriental*, or eastern Part of the Sky in the Morning before the Sun rises.

To Calculate the Place of SATURN.

SATURN is the higheſt *Planet* in the Syſtem, having the Orbits of all the reſt included within his Orb. The Time of his *Revolution* round the *Sun*, his *Diſtance*, *Aphelion*, *Perihelion*, *Nodes*, &c. are expreſſed in the preceding Table, and accurately projected on the Inſtrument.

This *Planet*, to us on the Earth, appears of a *dull Lead-colour*, and about the Size of *Aldebaran*, a Star of the firſt Magnitude. When viewed through a *good Teleſcope*, he appears to have a *Ring*, edge-ways, ſurrounding his Body, and five ſmall *Satellites*, or *Moons* revolving round him beyond the Ring; all which apparently lie in the Space of two Hands-breadths off his Body.

The Times of the *Revolutions* of theſe *Satellites*, with their apparent Diſtances from *Saturn's* Body, as obſerved through a good Teleſcope, are as here ſet down.

		D. H. M.		
The Firſt next him	revolves	1 : 21 : 19	at the	4¼ Semi-
Second	about	2 : 17 : 40	Diſtance	6¼ diameters
Third	Saturn	4 : 12 : 25	of	12¾ of
Fourth	in	15 : 22 : 41		20¾ Saturn's
Fifth		79 : 7 : 48		59¾ Body.

Theſe Moons turn (like Ours) once round their Axes in every Revolution; and conſequently keep the ſame Face always towards Saturn's Body.

The Diameter of his *Ring* is about 2¼ of *Saturn*'s Diameter.

When *Saturn* is in the Middle of *Gemini* and *Sagitarius*, the Ring appears through the Glaſs quite *open*: But when in *Piſces* and *Virgo* the Ring ſeems *ſhut*; appearing as a right Line acroſs his Body. The Plane of the Ring is nearly parallel to the Plane of our Equator.

Every Year and 13 Days he is conjoined to the Sun, and appears to move *direct*, to become *ſtationary*, and to run *retrograde* to us every Year. —— His great Diſtance prevents our diſcovering his *Revolution* round his *Axis*; ſo that, that Phænomenon remains, at preſent, not *perfectly* defined.

His Place in the *Ecliptic*, at any Time, may be eaſily calculated in the following Manner*.

* The Calculations of the *Places*, *Immerſions*, and *Emerſions* of the *Satellites* of this Planet, with thoſe of *Jupiter*, will be exhibited in a Work of itſelf.

EXAMPLE.

EXAMPLE.

Anno 1766, *November* 1st Day at *Noon*, I would know (by the Inſtrument) the *Heliocentric* and *Geocentric* Place of *Saturn* in *Longitude* and *Latitude:* His *Diſtance* from the *Sun* and from the *Earth:* And alſo, whether he is *direct*, *ſtationary*, or *retrograde*, at that Time.

OPERATION.

Write out the *Anomalies* of the *Earth* and *Saturn*, and equate them from the Tables thus:

Anomaly of ☉.	S.	D.	M.
1761 -	6 -	1 -	34
5 -	11 -	29 -	42
Nov. -	9 -	29 -	37
1st Day -	0 -	0 -	59
Mean Anomaly -	4 -	1 -	52
Equation ſubtract	0 -	1 -	40
True Anomaly -	4 -	0 -	12

Anomaly of ♄.	S.	D.	M.
1761 -	3 -	5 -	5
5 -	2 -	1 -	2
Nov. -	0 -	10 -	10
1st Day -	0 -	0 -	2
Mean Anomaly -	5 -	16 -	19
Equation ſubtract	0 -	1 -	42
True Anomaly -	5 -	14 -	37

Having rectified the Inſtrument, by bringing the *Aphelion* Point of Saturn's Orbit oppoſite the Beginning of the outer Circle, letting it reſt there;—lay *one of the Threads* on the *Earth's Anomaly* 4ˢ. 0°. 12′. on the upper Part, and it will cut her *true Place* in the *Ecliptic*; *i. e.* ♉ 9°¼ —— Next, lay *another Thread* to *Saturn's Anomaly* 5ˢ. 14°. 37′. on the lower Part, and it cuts the Ecliptic in his *Heliocentric Place* in ♊ 14°¼. —— The Threads remaining in this Poſition, lay the *graduated Edge* of the *Index* from *Saturn* to the *Earth*: Bring the *other Thread* parallel to it (by Help of a Pair of Dividers), and that Thread will cut the *Ecliptic* in almoſt 19° of ♊, which is his *Geocentric Place*, or Place, at that Time, ſeen from the *Earth*, as the other was ſeen from the *Sun**.

Saturn is now *retrograde*, not only becauſe the *Index* cuts or falls conſiderably within the Earth's Orbit on this Side the Sun; but alſo, becauſe the Angle made by the Threads at the Sun is leſs than 66°.—His Diſtance from the *Sun*, meaſured with the *Index* (or a Pair of Dividers), is about 739 Millions of Miles: His Diſtance from the *Earth*, about 670 Millions: His Diſtance from the neareſt *Node* is 36°¾, which gives, by the Tables at the End, for his Heliocentric Lat. or Inclination 1°. 29′. *South Aſcending*; but his Geocentric Lat. is 1°. 38′. *per* Rule at Page 15th.——He ſhines in the Evening; and his *Ring*, which is now almoſt open, may be ſeen, and one or more of his *Satellites*, with a tolerable Teleſcope.

* As the Inſtrument now lies, there is formed a Triangle, in which is exhibited the Method of calculating by aſtronomical Tables; for there are given the *Angle* at the *Sun*, and (the Logarithms of) the *two Sides*, to find the *Angle* at the *Planet*; which, if the *Angle* at the *Sun* be *leſs* than 6 Signs, muſt be *added to*, but if *more*, *ſubtracted from* the *Heliocentric Place* to give the *Geocentric*. This holds in the Superior Planets, but in the Inferior the Angle is applied juſt contrarywiſe, as the parallel Thread will ſhew you at all Times. For that Thread ever forms the ſame Angle at the Sun, as is made (by the Index) at the Planet; and falls either to the right or left Hand of the *Heliocentric Place*, as the Angle at the Planet by its Addition or Subtraction would make it.

To Calculate the Place of JUPITER.

NEXT within the Orbit of *Saturn* revolves the refulgent Planet *Jupiter*. He is a glorious Star of the *firſt Magnitude*, and greatly reſembles *Sirius*, the great Dog-ſtar, in Splendor, Colour, and Brightneſs.

Through an ordinary Teleſcope, he appears to ſhine with a *full Face*, and to have ſeveral *Belts* on his Body; in the lower of which is a large *Spot*, by which his *Rotation* upon his *Axis* was diſcovered, and that his *Axis* is nearly perpendicular to his Orbit.—Round his *Equator*, or middle Parts, may be ſeen, with the ſame Glaſs, to revolve *four* ſmall *Satellites*, or *Moons*, all which, when viſible, lie nearly in a Right Line, and within a *Hands Breadth or two* of his Body: But the Poſition of that Line has reſpect to the Situation of the *Ecliptic* at that Time. ——The outermoſt *Satellite* paſſes wide of the Shadow of *Jupiter*, two Years in every ſix; but the other three paſs through his Shadow in every Revolution, and are then *eclipſed*, and alſo *eclipſe* one another.

Beſides theſe *Immerſions* into his Shadow, they become twice inviſible to us in each Revolution (except when the Latitude is too great); that is, once, when they are between the Eye and *Jupiter*; and again, when they are behind his Body.

Jupiter's *Moons*, or *Satellites*, revolve round his Body in the Times, and at the Diſtances here expreſſed.

		D.	H.	M.			
The First	revolves round him in	1	18	36	at the Diſtance of	5¾	Semi-diameters of Jupiter's Body.
Second		3	3	15		8¾	
Third		7	3	59		14¾	
Fourth		16	18	30		25	

When *Jupiter* is our *Morning Star*, and riſes before the Sun, the Spectator ſees only the *Immerſions*, or Entrance of the *Satellites* into *Jupiter*'s Shadow. But when he is our *Evening Star*, and ſets after the Sun, we then ſee the *Emerſions* out of his Shadow.

Every Year and 33 Days he is conjoined with the Sun, and then, for about 34 Days, lies hid under the Sun's Beams, and conſequently becomes, at that Time, inviſible to the naked Eye.

The other *Phænomena* of this Planet are exhibited in the former Table; and his Place at all Times may be eaſily found by the Inſtrument, as follows.

EXAMPLE

EXAMPLE.

Anno 1766, *November* 1ſt Day at *Noon*, let it be required to find the *Heliocentric* and *Geocentric* Place of *Jupiter*, his *Latitude*, and *Diſtance* from the *Sun* and from the *Earth*, and if he be *direct* in Motion, or *ſtationary*, or *retrograde*.

OPERATION.

From the Tables collect the *Anomalies* of the *Earth* and *Jupiter*, with their *Equations*, as under.

Anomaly of ☉.	S.	D.	M.
1761 -	6 -	1 -	34
5 -	11 -	29 -	42
Nov. -	9 -	29 -	37
1ſt Day. -	0 -	0 -	59
Mean Anomaly -	4 -	1 -	52
Equation ſubtract	0 -	1 -	40
True Anomaly -	4 -	0 -	12

Anomaly of ♃.	S.	D.	M.
1761 -	4 -	27 -	20
5 -	5 -	1 -	42
Nov. -	0 -	25 -	16
1ſt Day -	0 -	0 -	5
Mean Anomaly -	10 -	24 -	23
Equation add -	0 -	3 -	3
True Anomaly -	10 -	27 -	26

Having brought the *Aphelion* of *Jupiter* to the Beginning of the outer Circle, lay a Thread to his Anomaly, 10ˢ. 27°. 26′. on that Circle, and it will cut the Ecliptic in ♍ 8°¼, which is his *Heliocentric* Place.—Another Thread brought to the *Earth's Anomaly* 4ˢ. 0°. 12′. on the upper Circle, cuts her *Heliocentric* Place (as before) in ♉ 9°¼*. —Then the *Index* being laid from *Jupiter* in his Orb to the *Earth* in her's, and the other Thread brought parallel to it, that Thread will cut the Planet's *Geocentric* Place in almoſt ♍ 16°¼.

Jupiter is now *direct* in Motion, becauſe the Index falls within the *Earth*'s Orbit, and he is *beyond* the Sun; and the Angle made at the Sun by the two Threads is more than 52°½. —He is now advancing towards his *Aphelion*, and ſhines glorioufly in the *Morning*. — His Diſtance from the neareſt *Node* is 59°¾; which gives for his Heliocentric Lat. 1°. 9′.—His Diſtance from the *Sun* is about 440 Millions of Miles; and from the Earth, about 489 Millions; which makes his Geocentric Lat. 1°. 2′, *North Aſcending*.

Jupiter being now a *Morning Star*, may be ſeen, and all his *Satellites*, with a tolerable Glaſs, and their *Immerſions* into his Shadow (ſhould it ſo happen at that Time) as they paſs behind him.

* The Place of the *Sun* is always exactly oppoſite to the Place of the *Earth* (which the Reader will obſerve once for all). Conſequently, the *Heliocentric* Place of the *Earth*, and the *Geocentric* Place of the *Sun*, muſt be continually in *Signs* and *Degrees* of the *Ecliptic* directly oppoſite to one another. For this Reaſon it is, that Aſtronomers ſpeak of the *Motion* of the *Sun*; and in their Computations, from their Tables, uſe the Quantities of his *apparent* Motion, as if it was *real*.

To

To Calculate the Place of MARS.

MARS moves round the *Sun* in an Orb between the *Earth* and *Jupiter*. He appears of a *fiery red Colour*, and to the naked Eye of different Sizes; ſometimes as large as a Star of the *firſt* Magnitude; at other Times not ſcarcely ſo large as one of the *ſecond*.

Through the Teleſcope he appears to increaſe and decreaſe in Light like the *Moon*; and when three Signs diſtant, is nearly biſſected, or divided in *two*.

This Planet is five Times nearer us at one Time than another; conſequently, *his* Appearance, with reſpect to his Size, muſt be ſo much larger in the former Situation than the latter.——He makes all the Aſpects with the *Sun*, and in Oppoſition to that Luminary is almoſt as near the *Earth* as *Venus*: Much nearer than *Mercury* or any of the other *Planets* *.—Between each Conjunction with the *Sun* he ſpends about two Years and 50 Days—and becomes *direct*, *ſtationary*, and *retrograde* to us, as all the other Planets do.

He does not appear to have any *Satellites*, or *Moons*, ſurrounding him, tho' it is very probable he has one or more,—A broad clouded *Belt* has been obſerved to ſhadow nearly half his Diſk; and ſeveral *Spots* have been ſeen upon his Body, by which his Revolution on his Axis was diſcovered.

His *Diſtance* from the *Sun*, *Period*, *Aphelion*, *Node*, &c. &c. are inſerted in the foregoing Table, and therefore it becomes needleſs to repeat them here.—His Place in the Heavens, at any Time, is eaſily found from the Inſtrument thus.

* As *Mars*, when in Oppoſition to the Sun, appears about five Times larger in Diameter than when he is in Conjunction with him; he muſt be therefore five Times nearer us in one Poſition than the other: For the apparent Magnitudes of diſtant Objects *increaſe* or *decreaſe* in Proportion to their Diſtances from us; but this Planet *Mars* keeps always, nearly, the ſame Diſtance from the Sun; it is therefore plain, even to Demonſtration, that it is not the *Earth*, but the *Sun*, that is the Center of his Orbit, and of the Syſtem.

EXAMPLE.

EXAMPLE.

Anno 1766, *November* 1ſt Day at Noon, what is the Place of *Mars* in *Longitude* and *Latitude*; his *Diſtance* from the *Sun* and *Earth*; and his other *Aſpects* at that Time, as ſeen from hence.

OPERATION.

Collect the *Anomalies* of the *Earth* and *Mars*, with their *Equations*, and ſet them down thus.

Anomaly of ☉.	S.	D.	M.
1761 -	6 -	1 -	34
5 -	11 -	29 -	42
Nov. -	9 -	29 -	37
1ſt Day -	0 -	0 -	59
Mean Anomaly -	4 -	1 -	52
Equation ſubtract	0 -	1 -	40
True Anomaly -	4 -	0 -	12

Anomaly of ♂.	S.	D.	M.
1761 -	5 -	25 -	57
5 -	7 -	26 -	51
Nov. -	5 -	9 -	18
1ſt Day -	0 -	0 -	31
Mean Anomaly -	7 -	2 -	37
Equation add -	0 -	6 -	20
True Anomaly -	7 -	8 -	57

Bring the *Aphelion* of *Mars* to the Beginning of the *outer* Circle, and lay a Thread to his *Anomaly*, as expreſſed in the Operation above, and it falls in the *Ecliptic* upon his *Longitude* or *Heliocentric* Place, in almoſt ♈ 11°. A Thread laid alſo upon the *Earth's Anomaly*, gives for her *Heliocentric Place* ♉ 9°½. ——Next, lay the *Index* from *Mars* to the *Earth*, and bring the other Thread parallel thereto; it then cuts his *Geocentric Place* in ♒ 29½°, and *there* he appears as beheld from the *Earth*.

The *Diſtance* of *Mars* from the neareſt *Node* is 37°. and *his Heliocentric Latitude* 1°. 7′. His *Diſtance* from the *Sun* 114 Millions of Miles, and from the *Earth* 57 Millions; conſequently his *Geocentric Lat.* is 2°. 14′. *South Deſcending*.

This *Planet* is now an *Evening Star*, and *direct* in Motion: And, as he has lately paſſed his *Peribelion*, and is on the ſame Side in *Perigeon*, or near the *Earth*, he muſt appear large and brilliant, like a Star of the *firſt Magnitude*. But as the *Earth* advances further in her Orb, *Mars* will apparently grow leſs; and when they are come on oppoſite Sides the *Sun*, his Diameter will be almoſt five Times leſs; conſequently, his Light will be diminiſhed to one twenty-fifth Part of what it is at this Time.

OBSERVATIONS ON THE SYSTEM From the EARTH.

HAVING in the foregoing Part of this Treatiſe given the Reader a View of the Syſtem from the *Sun*, the Center of it; we will now review it with him from the *Earth*, the Planet on which he, at preſent, reſides: By this means he will be enabled to account for the various and ſeemingly irregular Appearances of the *Planets*; as why they ſometimes ſeem *bigger*, and ſometimes *leſs*; why they ſometimes move forwards, and backwards, and ſometimes ſeem not to move at all.—In Order to this it will be neceſſary to delineate the ſeveral Planetary Orbs, with the *Planets* upon them; and then, by transferring the Eye from the *Earth* to thoſe Bodies, he will inſtantly perceive all the *Phænomena* juſt as in the Syſtem itſelf *.

From the ſame Scheme it is evident, that to an Eye at the *Earth* the Planets *Mercury* and *Venus*, when on *this Side* the *Sun*, muſt paſs between us and him; and with a Teleſcope may ſometimes be ſeen to make a black Spot upon his Face. But when on the *other Side*, they paſs behind him; and in that Poſition he may ſometimes intervene and eclipſe them †.

The *dotted* Lines drawn from the *Earth*, touching the Orbs of *Mercury* and *Venus* on the Right Hand and on the Left, evidently ſhow that theſe Points are the greateſt Diſtance which thoſe Planets can ever be ſeen from the Sun. The Diſtance of *Mercury* is never more than 28 Degrees; nor of *Venus* more than 48. Theſe Diſtances are called their *greateſt Elongations* on either Side.

Apparent alſo it is from the Projection, that all the time *thoſe two* Planets paſs from their greateſt Elongations on the Right Hand, or Weſtern Side, round the *Sun*, to their greateſt Elongations on the Left Hand, or Eaſtern Side, they muſt ſeem to move through the Heavens according to the Order of the Signs; *i. e.* from ♈ to ♉, from ♉ to ♊, *&c.* But from their greateſt Elongation on the Left Hand, they appear to move the contrary Way, *i. e.* from ♊ to ♉, from ♉ to ♈, *&c.*—During this State they are ſaid to be *retrograde.*

When theſe Planets lie exactly between the *Earth* and the *Sun* they are ſaid to be in their *inferior Conjunctions*; and appear wholly dark, becauſe their upper Sides

* The *Moon*, which is our Earth's *Satellite*, revolves round the Earth in $27^d. 7^h. 43'$. Her various Phænomena, with the *Moons* of *Saturn* and *Jupiter*, will be conſidered in a future Work.

† From an Inſpection of this Scheme it is plain, that as a Spectator at the *Sun* would ſee the *Earth* (or any other Planet) revolve thro' the *Signs* of the *Ecliptic*; ſo to a Spectator on the *Earth* (or Planet) the *Sun* will apparently revolve the ſame Way, but always in the oppoſite Point. For it is well known, that a fixed Object (as the Sun is) appears to change its Place by the Motion of the Obſerver round it.

only

A

VIEW

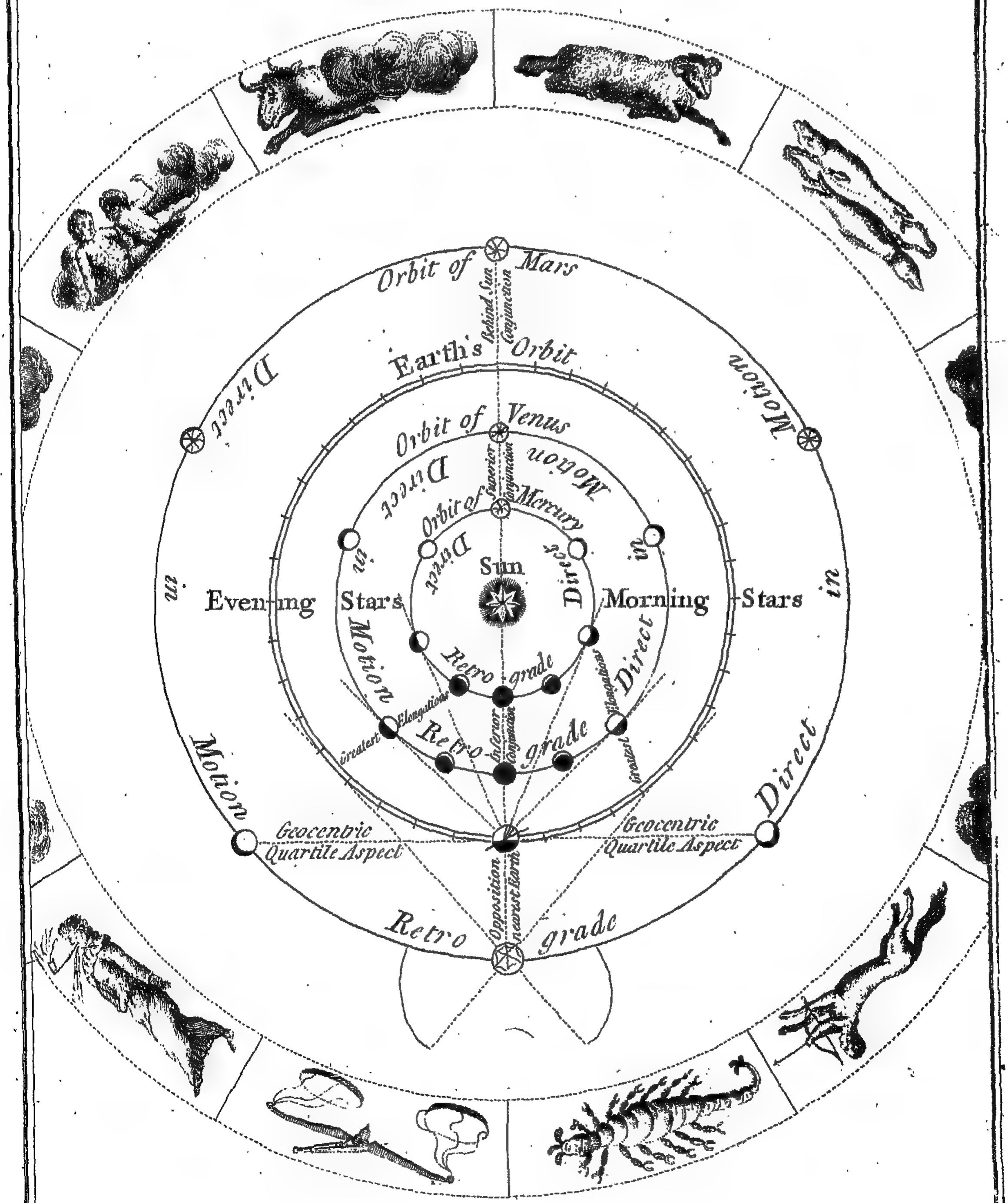
OF THE

SYSTEM from the EARTH,

The Place of our preſent RESIDENCE;

In which is clearly ſeen the true Reaſon of the *Directions*, *Stations*, *Retrogradations*, and *Elongations* of the Planets, and the different *Phaſes* they exhibit to us (in the different Parts of their Orbits) thro' the Teleſcope.

Page 24.



only are illuminated by the *Sun*. But as they recede from that Poſition, they turn ſome Part of their enlightened Surface towards us, and appear through the Teleſcope like a *New Moon* of three or four Days old. This Light will continue to increaſe as they paſs round the Sun to their *ſuperior Conjunctions*, where they turn their whole enlightened Hemiſphere towards us. From thence they begin to *decreaſe* in their Light, appearing firſt *gibbous*, then *biſſected*, and laſtly *horned*, as delineated in the Scheme.

Though *Venus* and *Mercury* (but particularly *Venus)* a little before their *Elongations* on the Right Hand, and a little after their *Elongations* on the Left Hand, turn but a ſmall Portion of their enlightened Surface towards us; yet they will appear more *large*, *brilliant*, and *glorious*, than in any other Parts of their Orbits; becauſe that ſmall Part will apparently contain, at thoſe Places, a greater Area of Light, than the whole Diſk when they are at their greateſt Diſtances, *four* or *five* Times farther off, *beyond* the *Sun*.

Theſe are the principal *Phænomena* of the *inferior* Planets *Mercury* and *Venus*: Let us proceed to view the *ſuperior*, *Mars*, *Jupiter*, and *Saturn*. But as the Phænomena of one of them, *viz.* of *Mars*, will fully elucidate and explain the the Appearances of them all, I ſhall, to prevent the Projection from ſwelling too wide, conſider the Revolution and Appearances of that Planet only.

When a *ſuperior* Planet, as *Mars*, is in that Part of his Orbit neareſt the Earth, on the ſame Side with her, he is ſaid to be in *Oppoſition* to the Sun; at which Time all the illuminated Surface of that Planet is turned towards the Earth, and he appears, through the Glaſs, *round* like a *Full Moon*. But as he proceeds towards his *Quartile Aſpect* he decreaſes in his Light, and appears there *gibbous*, or a little like a Moon a few Days before the *full*. As he goes on from thence, he recovers his Light, and ſhines with a full Face, till he arrives at his *Conjunction* with the *Sun*, where he becomes inviſible, on Account of the Sun's ſuperior Light. As he comes round from the Sun to his *Quartile Aſpect*, he appears *gibbous* again, but on the contrary Side; and then recovering *his Light as he advances*, ſhines with a full Orb to his *Oppoſition*.

☞ This Appearance cannot take Place in *Saturn* and *Jupiter*, on Account of their vaſt Diſtances, but is very conſpicuous in this Planet.

The *dotted* Lines from *Mars* to the Earth's Orb, ſhew the Places where the *Earth* appears at that Planet to be her *greateſt Elongation*, which never exceeds 34 Degrees.——The *Earth*, to an Eye at *Mars* will ſeem to paſs *retrograde* thro' the *inferior* Part of her Orb; but *direct* in Motion through the *ſuperior* Part; and will appear *horn'd*, *biſſected*, *gibbous*, and *full*, through the Glaſs, juſt as *Venus* does to us here. *Mars* will appear enlightened in like Manner (if viſible there) to the Inhabitants of *Jupiter*; and *Jupiter* to thoſe of *Saturn*.

☞ Theſe Appearances, which utterly confound and overthrow the *Ptolemaic* Hypotheſis, are concluſive Proofs of this *Copernican Syſtem*, and cannot fail of eſtabliſhing it upon a Foundation which ſhall be as laſting as that of the *Syſtem* itſelf.

To

To Calculate the Place of VENUS.

NEXT within the Orbit of the Earth revolves the Planet *Venus*. She is the moſt ſplendid and glittering of all the *Planets*; and ſo large as to be ſeen even in the Day Time.—— As the Orbit of this Planet is contained within the Orbit of our Earth, ſhe can never come in Oppoſition to the Sun, (as the ſuperior Planets *Mars*, *Jupiter*, and *Saturn* do) but always continues near him; being never more than 47 Degrees on either Side from him; which Diſtance is called her *greateſt Elongation*.

When ſhe is *orient*, *i. e.* on the *Weſtern Side* the Sun, ſhe comes to a *Conjunction* with him by *direct* Motion in the upper Part of her Orbit; and is then in *Apogee*, or moſt diſtant from us: But when ſhe is *occident*, *i. e.* on the *Eaſtern Side* the Sun, ſhe comes round to a *Conjunction* with the Sun by a *retrograde* Motion, and is then in *Perigee*, and about ſix Times nearer the Earth than in the former Situation; that is, nearer by the whole Diameter of her Orbit, as is plain by an Inſpection of the Inſtrument.

Through the *Teleſcope* ſhe appears to *increaſe* and *decreaſe* like the Moon; and is ſometime *horned* and ſometimes *gibbous*; which is a manifeſt Proof that her Orbit is wholly included within ours.

This Planet, when in *Conjunction* with the Sun in the upper Part of her Orbit, and near her Node, will paſs behind the *Sun*'s Body, and be eclipſed:—But when ſhe is in *Conjunction* with the Sun in the lower Part of her Orbit, *i. e.* in the Part next us, and very near her Node, ſhe may be ſeen, with the *Teleſcope*, to paſs over the *Sun*'s Face; making a *black Patch* upon him, like a *Beauty-ſpot* in a Lady's Face.

Venus can never be ſeen at *Midnight*; but only in the *Morning* and *Evening*, juſt as ſhe happens to be *Weſtward* or *Eaſtward* of the *Sun*. When ſhe appears in the Morning, ſhe is called the *Morning-ſtar*; and when in the Evening, ſhe is called the *Evening-ſtar**.——To us here, ſhe appears to be ſtationary and retrograde once every *two* Years. Her *Period*, *Diſtance*, *Aphelion*, and *Nodes*, and other Affections, are exhibited in the foregoing Table, and her Place in the Heavens is eaſily obtained in the following Manner.

* This Planet appears brighteſt and largeſt at about 40 Degrees from her inferior Conjunction, before and after it.

EXAMPLE.

EXAMPLE.

Anno 1766, *November* 1ſt Day at Noon, the Place of *Venus* is required both *Heliocentric* and *Geocentric*; alſo her Diſtance from the *Sun* and *Earth*; and whether ſhe be *direct*, *ſtationary*, or *retrograde* at that Time.

OPERATION.

Write down the *Anomalies* and *Equations* of the *Earth* and *Venus* from the Tables, as follow.

Anomaly of ☉.	S.	D.	M.
1761	6	1	34
5	11	29	42
Nov.	9	29	37
1ſt Day	0	0	59
Mean Anomaly	4	1	52
Equation ſubtract	0	1	40
True Anomaly	4	0	12

Anomaly of ♀.	S.	D.	M.
1761	1	26	22
5	1	15	29
Nov.	4	7	3
1ſt Day	0	1	36
Mean Anomaly	7	20	30
Equation add	0	0	37
True Anomaly	7	21	7

The Inſtrument being rectified, by bringing the *Aphelion* of *Venus* to the Beginning of the lower Circle; and the Threads laid to their reſpective *Anomalies*, will give in the *Ecliptic* for the *Longitude*, or *Heliocentric* Place of *Venus* ♍ $28\frac{1}{2}^{\circ}$, and for the *Earth*, ♉ $9\frac{1}{4}^{\circ}$.—The Index laid from *Venus* to the *Earth*, and the other Thread placed parallel to it, gives *Venus*'s *Geocentric* Place, ♍ $22\frac{1}{4}$.

At this Time *Venus* is diſtant from the neareſt *Node* about 76°. which gives by the Tables, her *Inclination*, or *Heliocentric Latitude*, 3°. 7′. Her Diſtance from the *Sun* is nearly 59 Millions of Miles, and from the *Earth* 130 Millions; therefore her *Latitude* from hence muſt be 1°. 29′. *North Deſcending*.

Venus is now *direct* in Motion, advancing towards her *ſuperior Conjunction*, and will be ſeen in the *Morning* before the *Sun*; at which Time, if viewed with a good Glaſs, ſhe will appear *gibbous*, or like a *Moon* a few Days before the Full.——She may alſo be ſeen in the Day-time by the ſame Glaſs, if it be directed properly to her Place in the Heavens. But the beſt Time to view this Planet by Day is, when ſhe is a few Degrees *before* or *after* her *inferior Conjunction*; for then ſhe appears *horned*, like a *New Moon*, with the illuminated Part turned towards the *Sun*.

To Calculate the Place of MERCURY.

WITHIN the Orbit of *Venus*, and next the *Sun*, revolves the Planet *Mercury*. He is the neareſt to the *Fountain* of *Light* of all the *primary Planets*. He is but ſeldom ſeen, becauſe his Orb lies ſo near the Sun; for at his greateſt Diſtance on either Side him, he is never found further than 27 or 28 Degrees.

This *Planet*, as well as *Venus*, can never come into *Oppoſition* with the *Sun*; nor be ſeen — only in the Evening juſt after Sun-ſet, or in the Morning juſt before he riſes.

Mercury becomes *direct*, *ſtationary*, and *retrograde* three or four Times every Year to us at the Earth; but, like *Venus*, makes no Aſpect with the *Sun* but his *Conjunction*.——When he is conjoined with the *Sun* in the upper Part of his Orb, he is always *direct* in Motion; and, if near his Node, will paſs behind the *Sun*'s *Body*: But when conjoin'd with the *Sun* in the lower Part of his Orb, he is ever *retrograde*; and, if near his Node, he may be ſeen, with a good Teleſcope to make a ſmall black Patch on the *Sun*'s *Diſk*.

At his *inferior Conjunction*, *Mercury* is nearer the Earth than at his *ſuperior Conjunction* by the Diameter of his Orbit.———He appears the *ſmalleſt* of all the primary Planets; — is of a ſparkling red Colour, greatly reſembling the Planet *Mars*, but not quite ſo large. — His lying ſo near the *Sun*, makes it impoſſible for us to make the ſame Obſervations on him with the Teleſcope as on the reſt of the Planets: For we have not been able (on Account of the Heavens being ſo ſtrongly illuminated by the Sun when he is viſible) to diſcover from hence any Spots on his Body, or if he revolve on his Axis or not.

The Time of his *Revolution* round the Sun, *Diſtance*, Places of his *Nodes*, *Aphelion*, &c. are before expreſſed in the general Table: and his Place, at any Time, is eaſily calculated as follows.

EXAMPLE

EXAMPLE.

Anno 1766, *November* 1ſt Day at Noon, ſuppoſe it be required to find by the Inſtrument the Place of *Mercury* in *Longitude* and *Latitude*, as ſeen from the *Sun* and from the *Earth*; alſo his *Diſtance* from thoſe Places; and whether he be *direct*, *ſtationary*, or *retrograde*, &c.

OPERATION.

From the Tables collect the *Anomalies* of the *Earth* and *Mercury*, and their *Equations*, as here ſet down.

Anomaly of ☉.

	S.	D.	M.
1761 -	6 -	1 -	34
5 -	11 -	29 -	42
Nov. -	9 -	29 -	37
1ſt Day -	0 -	0 -	59
Mean Anomaly -	4 -	1 -	52
Equation ſubtract	0 -	1 -	40
True Anomaly -	4 -	0 -	12

Anomaly of ☿.

	S.	D.	M.
1761 -	8 -	2 -	43
5 -	9 -	2 -	36
Nov. -	5 -	14 -	4
1ſt Day -	0 -	4 -	6
Mean Anomaly -	10 -	23 -	29
Equation add -	0 -	11 -	32
True Anomaly -	11 -	5 -	1

Bring the *Aphelion* of *Mercury* (as you did the reſt of the Planets) to the Beginning of the *outer* Circle; lay the Threads to their *Anomalies* ſeverally, and they will cut the Ecliptic in ♉ 9¼°. for the Place of the *Earth*, and ♏ 18 °. for the Place of *Mercury*, as ſeen from the *Sun*.—Lay the Index from the *Earth* to *Mercury* (which is almoſt a Right-line); bring the other Thread parallel to it, and it will fall upon ♏ 12¾°. his true Place ſeen from the *Earth*.

Mercury is now about 3 Degrees from the *Node*. His Inclination, or *Latitude* at the Sun, is 22′. His *Diſtance* from the *Sun* is 36 Millions of Miles, and from the *Earth* 116 Millions; which gives his *Latitude*, as ſeen from the Earth, about 7′. *South Deſcending*.

He is now in the upper Part of his Orbit; is in *Apogeon*; has juſt paſt his *ſuperior Conjunction*, and is *direct* in Motion; but lies ſo near the Sun as not to be *viſible*, riſing and ſetting nearly at the ſame Time with him.

☞ If two white *Beads*, having that Half blacked oppoſite the Sun, be brought, one of them to the Earth's Place, the other to the Planet's in their Orbs, you may pleaſantly ſee how much of that Planet appears to be illuminated at the Earth, and alſo what Aſpect the Earth appears in at that Planet.

To

To Calculate a TRANSIT of VENUS over the SUN's DISK.

AS the Orbit of *Venus* is wholly included in the Earth's Orbit, ſhe muſt ſometimes interpoſe between *us* and the *Sun*; and if that Interpoſition ſhould happen at either of her *Nodes*, (that is, juſt at the Interſection of her Orbit with the Plane of the Earth's Orbit) ſhe muſt apparently paſs over the Sun's Face.——The Places where theſe two Interſections are made are at 14 Deg. 34 Min. of *Gemini*, and 14 Deg. 34 Min. of *Sagitarius*.—The former is the Place of her *Aſcending Node*; *i. e.* where ſhe aſcends above the Plane of the the Earth's Orbit;—The other is her *Deſcending Node*, or Place where ſhe deſcends below it. *Tranſits* of this Planet can therefore only happen in thoſe Months in which the Earth is in theſe two Signs, and near the Degrees where the *Nodes* are ſituate; that is, in the Beginning of *June* and *December*: At all other Seaſons of the Year, that Planet will paſs under or over the Sun's Diſk, without producing that agreeable *Phænomenon*.

Now it has been found by *Aſtronomical Calculation*, that *Venus* will return to the ſame Situation with the *Earth* every 8 Years, 235 Years, and 243 Years nearly: *Tranſits* will therefore happen at the End of theſe Intervals; but more exactly as expreſſed in the following Tables.

A TABLE of the Periods of VENUS's Retrograde Conjunction with the *Sun* at the *Aſcending Node* in the Month of *December*.

	Years.	D.	H.	M.		Latitude of Venus.
Add	8—ſubt.	2	10	52½		24′ : 41″ South.
	235—add	2	10	9		11 : 33 North.
	243—ſubt.	0	0	43	if Common Year	13 : 8 South.
	243—add	0	23	17	if Leap Year	

Angle of the viſible Way of *Venus* over the Sun's Diſk	-	9° : 5′ : 0″	
Semidiameter of the *Sun* at that Time	- - - -	0 : 16 : 21	
The Hourly Motion of *Venus* within the Sun	- -	0 : 4 : 7	
Conſequently, the *greateſt* Duration of the *Tranſit* is	-	7ʰ : 56′ : 0″	

Venus was within the *Sun's Diſk* at this Node, *New Style*,
1639, *December* 5 D. 6 H. 37 M. with 8 M. 30 Sec. *South Latitude*.

A TABLE of the Periods of VENUS's Retrograde Conjunction with the *Sun* at the *Deſcending Node* in the Month of *June*.

	Years.	D.	H.	M.		Latitude of Venus.
Add	8—ſubt.	2	6	58		19′ : 58″ North.
	235—add	2	8	18		9 : 21 South.
	243—add	0	1	23		10 : 37 North.

☞ In Leap Year ſubtract or add one Day more.

Angle of the viſible Way of *Venus* over the Sun's Diſk	-	8° : 28′ : 0″	
Semidiameter of the *Sun* at that Time	- - - -	0 : 15 : 50	
The Hourly Motion of *Venus*	- - - - -	0 : 4 : 0	
And, the *greateſt* Duration of the *Tranſit* is	- -	7ʰ : 56′ : 0″	

Venus was ſeen within the *Diſk* of the *Sun* at this Node,
1761, *June* 5 D. 17 H. 55 M. with 4 M. 15 Sec. *South Latitude*.

* For the Rationale of theſe Numbers, ſee Dr. *Halley*'s Diſcourſe in the Philoſophical Tranſactions, N°. 193,—or *Whiſton*'s *Lectures*.

From

From the Periods of *Venus* here laid down, it will be very eaſy to compute the Time of any future *Tranſit*, by Addition and Subtraction only. For if to the Time of any *Tranſit* given, you add or ſubtract the firſt Period, and increaſe or decreaſe the *Latitude*, as much as the Table directs at that Period, you will have the Return of the next Conjunction of *Venus* with the *Sun* at that *Node*, with her *Latitude* at that Time; which if leſs than the Sun's Semidiameter, there will happen another *Tranſit*.

If the firſt Period does not bring the *Latitude* within the Limits preſcribed, you muſt try with the ſecond Period; and if that does not do, apply the third Period: Always remembering to uſe the firſt before the ſecond, and the ſecond before the third; as in the following Example.

EXAMPLE I.

I would know the Time of the next *Tranſit* of *Venus* over the *Sun* at the *Aſcending Node* in the Month of *December*.

OPERATION.

		Year.	D.	H.	M.	M. Sec.
Venus in the ☉ at Aſcending ☊		1639	Dec. 5	: 6	: 37	Lat. 8 : 30 South.
Firſt Period -	add	8	ſubt. 2	: 10	: 52*	24 : 41 South.
		1647	Dec. 2	: 19	: 45	33 : 13 South.

Hence it appears that *Venus* will paſs below the *Sun*'s *Diſk*, becauſe her *Latitude* exceeds the Sun's Semidiameter, 16′. 21″. by many Minutes. We muſt therefore try the ſecond Period.

		Year.	D.	H.	M.	M. Sec.
Venus in the ☉ at Aſcending ☊		1639	Dec. 5	: 6	: 37	Lat. 8 : 30 South.
Second Period -	add	235	add 2	: 10	: 9	† 11 : 33 North.
		1874	Dec. 7	: 16	: 46	3 : 3 North.

At this Time *Venus* will be ſeen in the *Sun*, and will paſs over his Diſk, about 3 Minutes northward of his Center.

EXAMPLE II.

I would alſo know when the next *Tranſit* of *Venus* will happen at the *Deſcending Node* in the Month of *June*.

OPERATION.

		Year.	D.	H.	M.	M. Sec.
Venus in the ☉ at Deſcending ☋		1761	June 5	: 17	: 55	Lat. 4 : 15 South.
Firſt Period -	add	8	ſubt. 2	: 6	: 58	19 : 58 North
		1769	June 3	: 10	: 57	15 : 43 North.

Theſe are all the *Tranſits* of *Venus* that will happen in *this* and the *next* Century.

* In this Example you *add* the Years, but *ſubtract* the Days, Hours, and Minutes.

† Here you muſt ſubtract the *leſs Latitude* from the *greater*, becauſe they are *different*: But when alike (*i. e.* both *North*, or both *South*), add them together.

To Calculate a TRANSIT of MERCURY over the SUN's DISK.

THE Orbit of *Mercury* (as well as that of *Venus*) lying within the Orbit of the Earth, there muſt neceſſarily happen the like Appearances in this Planet as in that; but they are more frequent in *Mercury* than in *Venus*, becauſe of his quicker Circulation, and ſpeedier Arrival to the ſame Places with the Earth. The *Nodes* of this Planet, *i. e.* the Places where his Orbit cuts the Plane of the Earth's Orb are in 15°.45′, of *Taurus*, where he aſcends above the *Ecliptic*; and in 15°.45′ of *Scorpio*, where he deſcends below it. All *Tranſits* of *Mercury* muſt happen in the Beginning of *May* and *November*, when the Earth is in thoſe Signs where his Nodes are.

The ſeveral Periods of *Mercury*'s Conjunction with the Sun, both at the *Aſcending* and *Deſcending Node* (as determined by Aſtronomical Obſervations and Calculations), are exhibited in the following *Tables*.

A TABLE of the Periods of MERCURY's Retrograde Conjunction with the *Sun* at the *Aſcending Node* in the Month of *November*.

	Years.	D.	H.	M.		Latitude.
Add	6—add	8	17	25	If 2d or 3d paſt Biſſextile	30′ : 50″ North.
	6—add	9	17	25	If Biſſextile, or 1ſt paſt	
	7—ſubt.	7	0 add 9		If 2 Biſſextiles in the Time	22′ : 47″ South.
	7—ſubt.	6	0 add 9		If 1 Biſſextile - - -	
	13—add	2	17	34	If 3d after Biſſextile -	8′ : 3″ North.
	13—add	1	17	34	If Biſſextile - - - - -	

The Angle of *Mercury*'s viſible Way over the Sun - 8° : 15′ : 0″
The *Sun*'s apparent *Semidiameter* at that Time - 0 : 16 : 5

Mercury was in the *Sun* at this Node, *New Style*,
1756, *Nov.* 6 D. 16 H. 36 M. with 0 M. 39 Sec. *South Latitude*.

A TABLE of the Periods of MERCURY's Retrograde Conjunction with the *Sun* at the *Deſcending Node* in the Month of *May*.

	Years.	D.	H.	M.		Latitude.
Add	13—add	3	7	37	- -	16′ : 55″ South.
	20—ſubt.	4	8	0	- -	30 : 57 North.
	33—ſubt.	1	0	23	- -	14 : 2 North.
	46—add	7	14	0	- -	2 : 53 South.
	79—ſubt.	0	17	9	- -	8 : 16 North.
	265—add	0	11	49	- -	22 : 0 South.

☞ If it be Leap Year, add or ſubtract one Day more.

The Angle of the viſible Way of *Mercury* over the *Sun* - 10° : 18′ : 0″
The apparent *Semidiameter* of the *Sun* - - - - - 0 : 15 : 46

Mercury was in the *Sun* at this Node, *New Style*,
1753, *May* 5 D. 19 H. 20 M. with 1 M. 19 Sec. *South Latitude*.

In

In the ſame Manner as you calculated the Times of the future *Tranſits* of *Venus*, you may calculate, by theſe Tables, thoſe of *Mercury*: An Example or two will make all plain.

EXAMPLE I.

Suppoſe you would know the next *Tranſit* of *Mercury* over the *Sun* at the *Aſcending Node* in the Month of *November*.

As *Mercury* (at the Time of the laſt *Tranſit*) had ſuch *ſmall Latitude*, I perceive immediately, from the Table, that the *Latitude* of *Mercury* at the two firſt Periods is too *great* to produce that Phænomenon: For at the End of the firſt Period of ſix Years he will go *North*, and in the ſecond of ſeven Years *South* of the *Sun*'s *Diſk*: I therefore make uſe of the third Period thus.

	Years.	D.	H.	M.		M.	Sec.	
Mercury was in the ☉	1756	Nov. 6	: 16	: 36	with Lat.	0	: 39	S.
The third Period -	13	add 2	: 17	: 34		8	: 3	N.
Next Tranſit at Aſcending ☊	1769	Nov. 9	: 10	: 10		7	: 24	N.

EXAMPLE II.

When will *Mercury tranſit* the *Sun* next, at the *Deſcending Node* in the Month of *May*?

In this Example, the *Latitude* of *Mercury* carrying him above or below the Diſk in the two firſt Periods, I apply the third, as under.

	Years.	D.	H.	M.		M.	Sec.	
Mercury in the ☉ at Deſcending ☊	1753	May 5	: 19	: 20	with Lat.	1	: 19	S.
3d Period, becauſe Leap Year, add	33	ſubt 2	: 0	: 23		14	: 2	N.
Next Tranſit at Deſcending ☊	1786	May 3	: 18	: 57		12	: 43	N.

In this Example I ſubtracted one Day more on Account of its being Leap Year.

☞ When the *Latitudes* are both of one Name, *add* them together; but when of different Names *ſubtract* the ſmaller from the larger, and the Remainder will be *Latitude* at that Time.

The other *Tranſits* of *Mercury* which fall within this Century, are,

Years.	D.	H.	M.		M.	Sec.	
1776 Nov.	2	: 10	19	with	15	: 23	South Latitude.
1782 Nov.	11	: 3	44		15	: 27	North Latitude.
1786 May	3	: 18	57		12	: 43	North Latitude.
1789 Nov.	5	: 3	53		7	: 20	South Latitude.
1799 May	7	: 2	34		4	: 12	South Latitude.

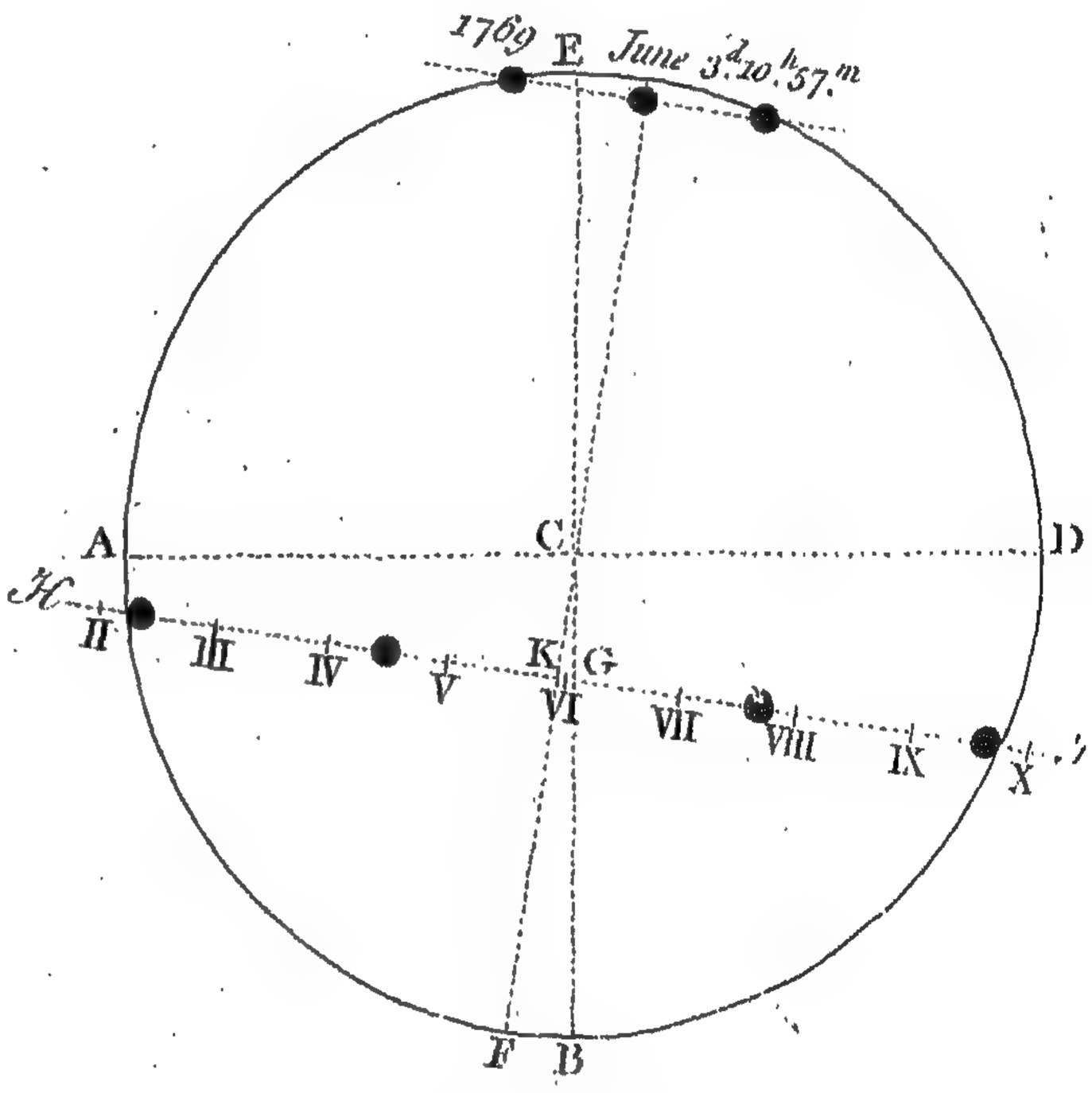
☞ If to any of theſe Periods of *Venus* or *Mercury* you find the Planet's *Anomaly* with the *Earth*'s, and lay the Threads thereto, you will find them lie upon each other; which proves them to be, at that Time, in Conjunction, if viewed from the Sun: Conſequently, the Planet ſeen from the *Earth* (as it is then near the *Node*) will appear in the *Sun*'s *Diſk*.

To

To Delineate a TRANSIT of VENUS (or Mercury) over the SUN's DISK.

(Suppoſe that which happened June 5th, 17 H. 55 M. or the 6th Day, 55 M. paſt 5, in the Morning, 1761, with 4′. 15″. South Latitude).

FROM any Scale of equal Parts, take off, with a Pair of Dividers, 15′.50″. = the Semidiameter of the Sun, and draw the Circle ABDE, which will repreſent the Sun's viſible Diſk.—Through the Center C draw the Line AD, to repreſent the *Ecliptic*, and croſs it in the Middle with the other EB, for the Axis of the *Ecliptic*.—Then with a *Protractor*, or Line of Chords, ſet off the Angle of 8°.28′.= the Angle of the *viſible Way* of *Venus* from B towards F, becauſe that Planet is retrograde, and Latitude Aſcending, or Increaſing South; and draw CF for the Axis of *Venus*'s Way.—Take the Latitude 4′.15″. at the Time of that Conjunction, from the ſame Scale of equal Parts, and ſet it on the Axis of the Ecliptic from C to G, and draw HI through the Point G, at Right Angles to CF; ſo will HI deſcribe the viſible Path of *Venus over the Sun*.



And as the longeſt Time of any *Tranſit* of *Venus* is when ſhe paſſes over the Middle of the Sun at AD, which is performed in 7h.56′. or eight Hours nearly, you have, by dividing the Diameter into eight equal Parts, the Space that *Venus* deſcribes upon the Diſk in one Hour.—And as the Middle of this *Tranſit*, at K, happens at 55′ paſt 5,--take off 5′ from one of the Hours, which you have previouſly divided into 60 equal Parts, and ſet them from K towards G; that will ſhow where *Venus* will be upon the Diſk at 6 o'Clock.—Next, take off the Length of one whole Hour, and ſet it from 6, each Way along the Path HI. By this Means you will obtain the Hours both before and after 6; which number'd as in the Scheme, will ſhew the Time of the Beginning of the *Tranſit* at H, and the End at I.——You may draw little Circles upon the Path, to repreſent *Venus* upon the Diſk. Her Diameter is about 1′ 15″. which is equal to one of the Diviſions of the Scale of equal Parts by which you projected the Diſk of the *Sun*.

The Path at the *upper* Part of the *Sun* repreſents the *Tranſit* of *Venus* which happened 1769, June 3 D. 10 H. 57 M. with 15′. 43″. North Lat. Deſcending.——Theſe are all the *Tranſits* of this Planet within this Century.

*** Theſe Calculations and Projections are according to the *mean Motions* and mean Latitudes of thoſe Planets, and may differ ſome little from the *true* Time; but will ſerve to illuſtrate and explain to the young Aſtronomer the Nature and Manner of a *Tranſit*, and enable him better to underſtand the Calculations from the exacteſt *Aſtronomical Tables*.

In all *Tranſits* at the *Deſcending Node* the Planets paſs over the Sun *deſcending*, and at the *Aſcending Node* they paſs the Diſk *aſcending*.

To

To find the Times of the OPPOSITIONS and CONJUNCTIONS of the Primary PLANETS.

SUPPOSE the Earth in *Conjunction*, &c. with any of the Superior Planets, *Mars*, *Jupiter*, or *Saturn*; then becauſe the Earth revolves with a quicker Motion in her Orbit than either of thoſe Planets, ſhe will every Day recede from them, ſo much as is the *Difference* of their *Motions*; and when ſhe has performed her Period, ſhe will not come up with them again, becauſe they have advanced with their Motion at the ſame Time: The Earth therefore muſt go on ſtill further to overtake thoſe Planets, and come to a Conjunction again: And to find how much, *ſay by the Rule of Proportion*———

As the *Difference* between the *Earth*'s and *Planet*'s Motion for any Time, ſuppoſe for *one Day*: — Is to *that Time*: : — So are 360°, the *whole Circle*: — To the *Time* they *meet again*.

By comparing the daily Motions of the *Earth* and the other *Planets* inſerted in the foregoing Table at Page the 10th, and making the above Proportions; we find the Time between two Conjunctions of the *Earth* and *Saturn* to be 378 Days, or 1 Year and 13 Days —Between two Conjunctions of the *Earth* and *Jupiter*, 398 Days, or 1 Year and 33 Days.—Between two Conjunctions of the *Earth* and *Mars*, 2 Years and 50 Days.—Between two of the *Earth* and *Venus* of the ſame Kind*, 1 Year and 218 Days.—And between two of the *Earth* and *Mercury* of the ſame Kind, 115 Days.

There is the ſame Time between two Conjunctions of the *Planets* with the *Sun*; or between any other two ſimilar Aſpects with Him.——And the Time between the *Oppoſition* and *Conjunction* of a *Planet* with the *Sun* is equal to *half* the Time of their Conjunctions ſpecified above.

The Times of theſe *Conjunctions* added to the former Conjunction found in any Almanack, *&c.* will give the Time of the next Conjunction following. —But as theſe *Periods* are computed according to their *mean Motions*, i. e. ſuppoſing them to move always in circular Orbits, (whereas they move in elliptical ones, moving ſometimes a *little faſter*, and ſometimes a *little ſlower*;) it may happen that the *true Conjunctions* may fall a Day or two ſooner or later than by the Calculation here given: *But the* true Time *will be always ſhewn by the Inſtrument*.

* By two Conjunctions of the ſame Kind in *Venus* and *Mercury* is meant two Conjunctions either in the *ſuperior*, or two Conjunctions in the *inferior* Parts of their Orbits.———Every *Conjunction* of *Venus* is made about 9 *Signs* further in the Ecliptic, and *Mercury* about 4 *Signs*; but the Time in *Mercury* is a little uncertain on Account of his great *Eccentricity*.

Of the *Direct*, *Stationary*, and *Retrograde Appearances* of the Primary PLANETS.

THE *Stations* and *Retrogradations* of the *Planets* in the Heavens are not *real*, but *apparent* only, being caus'd by the Revolution of the Earth, and the various Poſitions of it in its Orbit, as was ſhewn before in treating of that Planet; and therefore it becomes unneceſſary to repeat it here.

Tho' it is difficult to determine the exact Times of theſe Appearances by Calculation, yet the Inſtrument will ſhew them at all Times.——For if the *Index* when laid from the *Planet*'s Place in its Orbit to the Earth touches the Earth's Orb, that *Planet* appears *ſtationary* in the Heavens at that Time. But if the Index cuts the Earth's Orbit, and the *Earth* and *Planet* are on oppoſite Sides the *Sun*, the Planet is then *direct*; but if both of them are on the ſame Side, the Planet is then *retrograde*.

To eſtimate nearly the Times of the *Directions*, *Stations*, and *Retrogradations*, &c. of the *Planets*, I have here ſubjoined the following Table, which the *young Aſtronomer* will find of much Uſe to him, in underſtanding and aſcertaining theſe *Appearances*.

The Planets.	From one *Conjunction*, *Station*, and *Retrogradation* to another.	Days Direct.	Days Retrograde.	Degrees Retrograde.
Saturn	$1^y : 13^d$	238	140	7
Jupiter	1 : 33	279	120	10
Mars	2 : 50	700	80	20 15 10*
Venus	1 : 218	542	42	18
Mercury	0 : 115	92	24	16 $8\frac{1}{2}$

This Table is ſo clear and evident that it needs no Explanation: For you ſee that *Saturn* after 1 Year and 13 Days returns to the ſame Aſpect with the *Earth* (or *Sun*);—continues *direct* in Motion 238 Days;—then runs *retrograde* 140 Days;—and goes back 7 Degrees in the *Ecliptic* †.

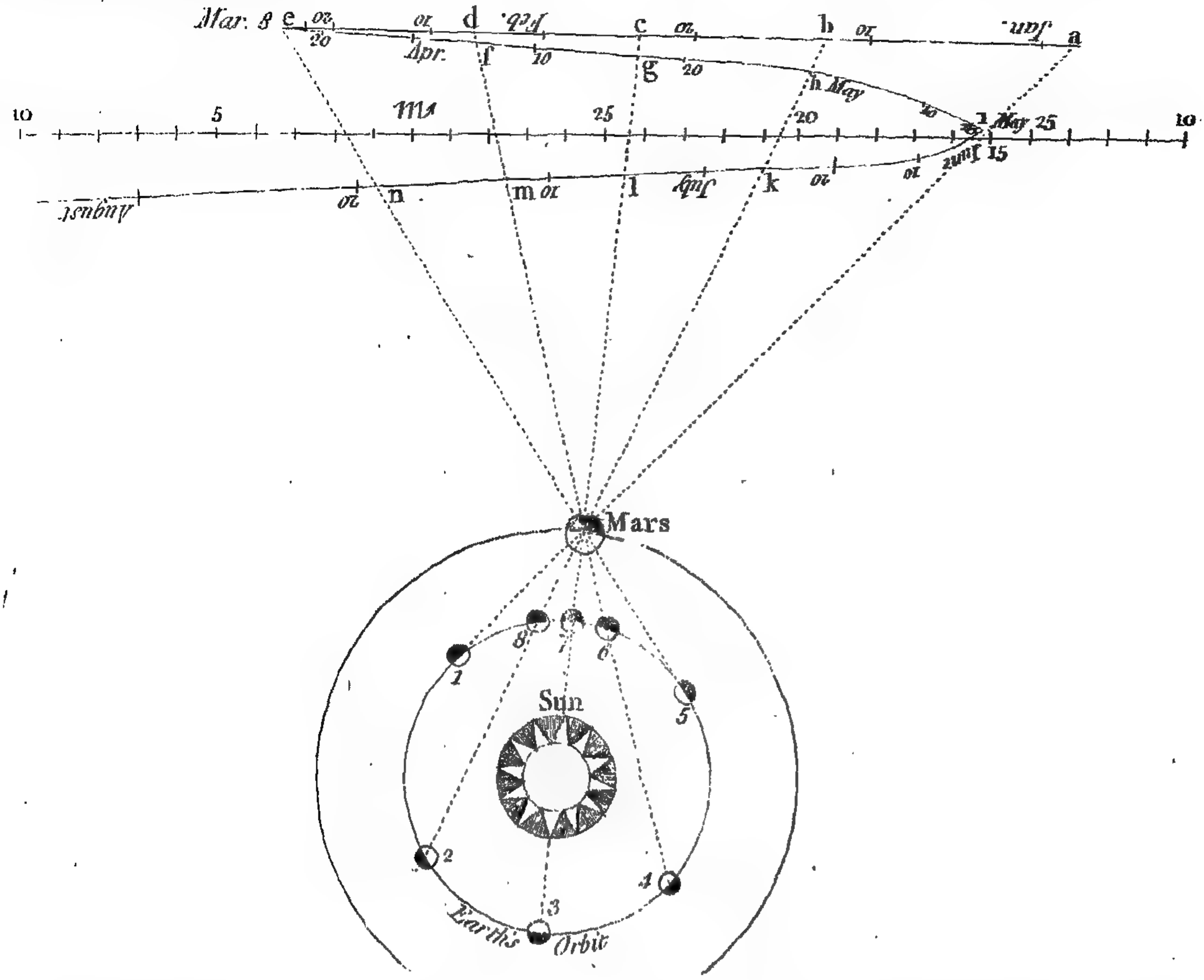
A *Planet* in his *retrograde Motion* does not deſcribe exactly the Tract back again which he paſſed through in his *direct* Motion, becauſe the *Latitude* is continually altering as ſeen from the Earth; ſo that ſometimes he may paſs a little above the *Ecliptic* Line; ſometimes a little below it.—To explain this more fully, I ſhall here ſubjoin the *direct* and *retrograde* Courſe of the *Planet*

* *Mars* and *Mercury* are *variable* in their *Retrogradations* on Account of the great *Eccentricity* of their Orbits.

† *Fromondus*, who was averſe to the annual Motion of the *Earth*, was obliged to confeſs that, that Motion was maintained by the *Copernicans* by no Argument more probable and ſpecious than that of the *Station*, *Direction*, and *Retrogradation* of the Planets.——Whiſton's Lectures, p. 203.

Mars,

Mars, which he took in the Year 1762, and alſo the Place where it was *ſtationary*; by which the Learner will be enabled to underſtand thoſe Appearances the better.



In this *Scheme*, the Center repreſents the *Sun*; the inner Circle the Orbit of the *Earth*, the other the Orbit of *Mars*.—The *Earth* being at 1, *Mars* is ſeen among the *fixed Stars* at a.— When the *Earth* is at 2, *Mars* is ſeen at b. When the *Earth* is come to 3, 4, and 5, *Mars* appears at c, d, and e.—Thus from a to e *Mars* moves *direct*, *i. e.* from *Weſt* to *Eaſt* in the Heavens.—But the *Earth* being at 5, *Mars* is ſeen at e to be *ſtationary*, or at a Stand, for a few Days.—As the *Earth* moves from 5 to 6, *Mars* is ſeen to return in a *retrograde* Direction from e to f.—The *Earth* going on from 6, to 7, 8, and 1, *Mars* ſtill proceeds to go *retrograde* from f, to g, h, and i.—At i *Mars* appears *ſtationary* again for a few Days.—The *Earth* removing from 1, to 2, 3, 4, and 5, *Mars* is ſeen to recover his *direct* Motion again, and to remove from i, to k, l, m, and n.

I have ſuppoſed *Mars* in this Projection to remain fixed in the ſame Place of his Orbit, in order to render the *direct* and *retrograde* Appearances evident to the *Pupil*; tho' it is certain he advances in his Orb the ſame Way, and at the ſame Time; but it would be very difficult to expreſs in a Drawing that *compound Motion*. But the direct and retrograde Lines at the Top, to which the Months are affixed, is the apparent Tract which that *Planet* deſcribed in 1762. and the *dotted* Line is a Portion of the *Zodiac* it paſſed thro' in that Time.—At the End of the preceding Year *Mars* was obſerved at a, in about 14° of *Libra*, with 2° of North Lat. from whence he proceeded *direct* thro' the Months *January*, *February*, and to the 8th of *March*; when he became *ſtationary* in about 3° 3′ of *Scorpio*, with 2° 32′ North Lat.—Thro' the Remainder of *March*, *April*, and to the 25th of *May*, he proceeded *retrograde*, his Latitude *decreaſing*, at which Time he became *ſtationary* again in about 15° of *Libra*.—From hence he began to move *direct* again, croſs'd the *Ecliptic* Line in about 15° 10′ of *Libra*, and went on thro' *June*, *July*, *Auguſt*, &c. with South Lat. to the End of the Year.

To

To determine the greateſt *Elongations* of the EARTH from the SUN, as beheld from any of the *Superior Planets*; and alſo, the greateſt *Elongations* of the *Inferiors* from the SUN as ſeen from the EARTH.

BRING a Thread from the *Sun* acroſs the *Inſtrument*, ſo as to cut the Orbits of all the *Planets*;---then lay the *Index* from the Interſections of the Thread with the Orbits of the *ſuperior Planets* to the outer Part of the *Earth*'s Orbit; and the ſeveral *Angles* meaſured at the *Planets* with a *Protractor*, (or by bringing another Thread *parallel* to the *Index*) will point out the greateſt Elongation of the Earth to each of theſe *Planets*:—And which you will find to be at *Saturn* about 6 Degrees:—At *Jupiter* about 11 Degrees:—At *Mars* about 42 Degrees.———But for *Venus* and *Mercury*, lay the Index from the Interſection of the Thread with the *Earth*'s Orbit to the Edge of their Orbits, and meaſure in like Manner the *Angle* at the *Earth*, and you'll have for the Elongation of *Venus* about 46 Degrees;---and *Mercury* about 22 Degrees*.

As theſe Elongations of *Venus* and *Mercury* are the greateſt Diſtances theſe two Planets ever appear from the *Sun*, either before or after him; ſo the above Elongations of the *Earth* from the *Sun* is the greateſt Diſtance that ever ſhe appears to thoſe Planets from him.——At *Mars* the *Earth* will never be ſeen to go farther from the *Sun* than about 42 Degrees, which is not ſo far as *Venus* is ſeen to do to us.——At *Jupiter* the Diſtance of the *Earth* will never be more than 11 Degrees from the *Sun*, which is *but half* the Diſtance that *Mercury* is found to be at here from the *Sun*; conſequently a Sight of the *Earth*, even to them, muſt be a very rare and unuſual *Phænomenon*.——And at *Saturn* the *Earth* can never be found to be more than 6 Degrees from the *Sun*; which Diſtance is not above *one fourth* of what we obſerve in *Mercury*: And as *Mercury* is ſeldom ſeen here, it is very probable that the *Earth* can never be ſeen there; and that the *Saturnian Aſtronomers* (if any) have not diſcovered that there is ſuch a *Planet* or *World* as our *Earth* in the *Syſtem*.

* *Mercury*, on Account of the great Eccentricity of his Orbit, will have very different Elongations:—Sometimes it will be about 27 Degrees, at other Times not more than 17 Degrees.——But the Elongations in the other Planets will ſeldom differ more than 1 Degree.

N E W

ASTRONOMICAL TABLES:

SHEWING,

The Mean ANOMALIES of all the Primary PLANETS,

WITH THE

EQUATIONS of their ORBITS;

By which their True DISTANCES from their APHELIONS may be eaſily aſcertained at any Time.

NEW TABLES,

Shewing the Mean ANOMALIES of all the Primary Planets (or their Diſtance from their Aphelion Points), in *Years* of Chriſt current, adapted to the *New Style*.

Theſe Numbers correſpond to the Old Style.						
Years of Chriſt.	Mercury ☿	Venus ♀	Earth ⊖	Mars ♂	Jupiter ♃	Saturn ♄
	s o ′	s o ′	s o ′	s o ′	s o ′	s o ′
1681	7 19 40	1 29 53	6 13 11	11 19 55	8 0 41	6 18 45
1701	8 4 11	8 3 25	6 12 59	7 7 52	4 7 34	2 22 55
1721	8 18 42	8 6 56	6 12 47	2 25 49	0 14 28	10 27 6
1741	9 3 13	8 10 28	6 12 35	10 13 46	8 21 21	7 1 16
The following Numbers agree to the *New Style*, which commenced September the 2d, 1752.						
	s o ′	s o ′	s o ′	s o ′	s o ′	s o ′
1761	8 2 43	1 26 22	6 1 34	5 25 57	4 27 20	3 5 5
1781	8 17 14	7 29 54	6 1 22	1 13 54	1 4 14	11 9 15
1801	8 27 40	2 1 48	6 0 9	9 1 20	9 11 2	7 13 24
1821	9 12 10	8 5 20	5 29 57	4 19 18	5 17 56	3 17 34
1841	9 26 41	2 8 52	5 29 45	0 7 16	1 24 50	11 21 44
1861	10 11 12	8 12 24	5 29 33	7 25 14	10 1 44	7 25 45

A TABLE of the Mean ANOMALIES of all the Primary Planets in *Months*.

Months.	Mercury ☿	Venus ♀	Earth ⊖	Mars ♂	Jupiter ♃	Saturn ♄
	s o ′	s o ′	s o ′	s o ′	s o ′	s o ′
January -	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
February - -	4 6 52	1 19 40	1 0 33	0 16 15	0 2 35	0 1 2
March - - -	8 1 27	3 4 32	1 28 9	1 0 55	0 4 54	0 1 58
April - -	0 8 19	4 24 11	2 28 42	1 17 10	0 7 29	0 3 1
May - - -	4 11 5	6 15 15	3 28 16	2 2 53	0 9 58	0 4 1
June - -	8 17 57	8 1 55	4 28 50	2 19 8	0 12 33	0 5 3
July - - -	0 20 43	9 19 59	5 28 24	3 4 51	0 15 2	0 6 3
August - -	4 27 34	11 9 39	6 28 57	3 21 6	0 17 37	0 7 5
September -	9 4 26	0 29 19	7 29 30	4 7 20	0 20 11	0 8 8
October -	1 7 12	2 17 23	8 29 4	4 23 4	0 22 41	0 9 8
November -	5 14 4	4 7 3	9 29 37	5 9 18	0 25 16	0 10 10
December -	9 16 50	5 21 7	10 29 11	5 25 2	0 27 43	0 11 11

☞ In *Leap Years*, after *February*, remember to take the Motion of one Day more.

A TABLE

Of the Mean ANOMALIES of all the Primary Planets in *Years compleat.*

Years compleat	Mercury ☿	Venus ♀	Earth ⊖	Mars ♂	Jupiter ♃	Saturn ♄
	s o ′	s o ′	s o ′	s o ′	s o ′	s o ′
1	1 23 42	7 14 47	11 29 44	6 11 16	1 0 9	0 12 12
2	3 17 24	2 29 33	11 29 29	0 22 32	2 0 39	0 24 24
3	5 11 6	10 14 20	11 29 14	7 3 48	3 0 58	1 6 36
4	7 8 54	6 0 43	11 29 58	1 15 35	4 1 23	1 18 50
5	9 2 36	1 15 29	11 29 42	7 26 51	5 1 42	2 1 2
6	10 26 19	9 0 15	11 29 27	2 8 7	6 2 2	2 15 14
7	0 20 0	4 15 2	11 29 11	8 19 23	7 2 21	2 25 26
8	2 17 48	0 1 25	11 29 55	3 1 11	8 2 45	3 7 40
9	4 11 31	7 16 11	11 29 40	9 12 27	9 3 5	3 19 52
10	6 5 13	3 0 58	11 29 24	3 23 43	10 3 24	4 2 4
11	7 28 55	10 15 41	11 29 9	10 4 59	11 3 46	4 4 16
12	9 26 42	6 2 7	11 29 53	4 16 46	0 4 8	4 26 30
13	11 20 25	1 16 54	11 29 37	10 28 2	1 4 28	5 8 42
14	1 14 7	9 1 40	11 29 22	5 9 18	2 4 47	5 20 54
15	3 7 47	4 12 27	11 29 7	11 20 34	3 5 6	6 3 6
16	5 5 37	0 2 49	11 29 50	6 2 22	4 5 31	6 15 20
17	6 29 19	7 17 36	11 29 55	0 13 38	5 5 50	6 27 32
18	8 23 1	3 2 22	11 29 20	6 24 54	6 6 10	7 9 44
19	10 16 43	10 17 9	11 29 4	1 6 10	7 6 29	7 24 56
20	0 14 31	6 3 32	11 29 48	7 17 58	8 6 54	8 4 10
40	0 29 2	0 7 3	11 29 36	3 5 54	4 13 47	4 8 21
60	1 13 33	6 10 25	11 29 24	10 23 51	0 20 41	0 12 32
80	1 28 3	0 14 6	11 29 12	6 11 49	8 27 35	8 16 42
100	2 12 34	6 17 28	11 29 0	1 29 46	15 4 28	4 20 52

A TABLE

A TABLE

Of the Mean ANOMALIES of all the Planets in *Days*.

Days	☿	♀	☉	♂	♃	♄
	s ° ′	s ° ′	s ° ′	° ′	° ′	° ′
1	0 4 6	0 1 36	0 0 59	0 31	0 5	0 2
2	0 8 11	0 3 12	0 1 58	1 3	0 10	0 4
3	0 12 17	0 4 48	0 2 57	1 3	0 15	0 6
4	0 16 22	0 6 25	0 3 57	2 6	0 20	0 8
5	0 20 28	0 8 1	0 4 56	2 37	0 25	0 10
6	0 24 33	0 9 37	0 5 55	3 9	0 30	0 12
7	0 28 39	0 11 13	0 6 54	3 40	0 35	0 14
8	1 2 44	0 12 49	0 7 53	4 12	0 40	0 16
9	1 6 50	0 14 25	0 8 52	4 43	0 45	0 18
10	1 10 55	0 16 1	0 9 51	5 14	0 50	0 20
11	1 15 1	0 17 37	0 10 50	5 46	0 55	0 22
12	1 19 6	0 19 14	0 11 50	6 17	1 0	0 24
13	1 23 12	0 20 50	0 12 49	6 49	1 5	0 26
14	1 27 18	0 22 26	0 13 48	7 20	1 10	0 28
15	2 1 23	0 24 2	0 14 47	7 52	1 15	0 30
16	2 5 29	0 25 38	0 15 46	8 23	1 20	0 32
17	2 9 34	0 27 14	0 16 45	8 55	1 25	0 34
18	2 13 40	0 28 50	0 17 44	9 26	1 30	0 36
19	2 17 45	1 0 26	0 18 44	9 57	1 35	0 38
20	2 21 51	1 2 2	0 19 43	10 29	1 40	0 40
21	2 25 56	1 3 39	0 20 42	11 0	1 45	0 42
22	3 0 2	1 5 15	0 21 41	11 32	1 50	0 44
23	3 4 7	1 6 51	0 22 40	12 3	1 55	0 46
24	3 8 13	1 8 27	0 23 37	12 35	2 0	0 48
25	3 12 18	1 10 3	0 24 38	13 6	2 5	0 50
26	3 16 24	1 11 39	0 25 38	13 37	2 10	0 52
27	3 20 30	1 13 15	0 26 37	14 9	2 15	0 54
28	3 24 35	1 14 52	0 27 36	14 40	2 20	0 56
29	3 28 41	1 16 28	0 28 34	15 12	2 25	0 58
30	4 2 46	1 18 4	0 29 34	15 43	2 30	1 0
31	4 6 52	1 19 40	1 0 33	16 15	2 35	1 2
32	4 10 57	1 21 16	1 1 32	16 46	2 40	1 4

☞ In *Leap Year*, after *February*, remember to add the Motion of a Day more.

A TABLE

Of the Mean ANOMALIES of all the Planets in *Hours.*

	☿	♀	⊖	♂	♃	♄
	° ′	° ′	° ′	° ′	° ′	° ′
1	0 10	0 4	0 2	0 1	0 0	0 0
2	0 20	0 8	0 5	0 3	0 0	0 0
3	0 31	0 12	0 7	0 4	0 1	0 0
4	0 42	0 16	0 10	0 5	0 1	0 0
5	0 51	0 20	0 12	0 7	0 1	0 0
6	1 1	0 24	0 15	0 8	0 1	0 0
7	1 12	0 28	0 17	0 9	0 1	0 1
8	1 22	0 32	0 20	0 10	0 2	0 1
9	1 32	0 36	0 22	0 12	0 2	0 1
10	1 42	0 40	0 25	0 13	0 2	0 1
11	1 53	0 44	0 27	0 14	0 2	0 1
12	2 3	0 48	0 30	0 16	0 2	0 1
13	2 13	0 52	0 32	0 17	0 3	0 1
14	2 23	0 56	0 34	0 18	0 3	0 1
15	2 34	1 0	0 37	0 20	0 3	0 1
16	2 44	1 4	0 39	0 21	0 3	0 1
17	2 54	1 8	0 43	0 22	0 4	0 1
18	3 4	1 12	0 44	0 24	0 4	0 1
19	3 14	1 16	0 47	0 25	0 4	0 2
20	3 25	1 20	0 49	0 26	0 4	0 2
21	3 35	1 24	0 52	0 27	0 4	0 2
22	3 45	1 28	0 54	0 29	0 5	0 2
23	3 55	1 32	0 57	0 30	0 5	0 2
24	4 5	1 36	0 59	0 31	0 5	0 2

The ANOMALIES of the Planets in *Minutes.*

	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
10	0 2	0 1	0 0	0 0	0 0	0 0
20	0 3	0 1	0 1	0 0	0 0	0 0
30	0 5	0 2	0 1	0 1	0 0	0 0
40	0 7	0 3	0 2	0 1	0 0	0 0
50	0 8	0 3	0 2	0 1	0 0	0 0
60	0 10	0 4	0 2	0 1	0 0	0 0

The EQUATION Of MERCURY'S ORBIT.

Mercury's Mean Anomaly	*Subtracted* from the *Mean Anomaly* gives the *True*.						Mean Anomaly
	0 Sign	1 Sign	2 Sign	3 Sign	4 Sign	5 Sign	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	
0	0 0	9 35	17 48	22 57	22 48	14 57	30
1	0 19	9 53	18 2	23 3	22 40	14 32	29
2	0 39	10 11	18 16	23 8	22 32	14 8	28
3	0 58	10 30	18 29	23 13	22 23	13 42	27
4	1 18	10 48	18 42	23 18	22 14	13 16	26
5	1 38	11 5	18 56	23 22	22 4	12 50	25
6	1 57	11 23	19 8	23 26	21 54	12 23	24
7	2 17	11 41	19 21	23 29	21 43	11 56	23
8	2 36	11 58	19 33	23 32	21 31	11 28	22
9	2 56	12 16	19 46	23 35	21 19	11 0	21
10	3 15	12 33	19 57	23 37	21 7	10 32	20
11	3 35	12 50	20 9	23 39	20 54	10 3	19
12	3 54	13 7	20 21	23 40	20 40	9 34	18
13	4 14	13 24	20 32	23 41	20 26	9 4	17
14	4 33	13 41	20 43	23 42	20 11	8 34	16
15	4 52	13 58	20 54	23 42	19 56	8 3	15
16	5 12	14 14	21 4	23 42	19 40	7 33	14
17	5 31	14 30	21 13	23 41	19 23	7 2	13
18	5 50	14 47	21 23	23 40	19 2	6 30	12
19	6 9	15 3	21 33	23 38	18 48	5 59	11
20	6 28	15 19	21 42	23 36	18 30	5 27	10
21	6 47	15 34	21 51	23 35	18 11	4 55	9
22	7 6	15 50	22 0	23 30	17 52	4 22	8
23	7 25	16 5	22 8	23 27	17 32	3 50	7
24	7 44	16 20	22 16	23 23	17 11	3 17	6
25	8 3	16 39	22 24	23 18	16 50	2 45	5
26	8 22	16 50	22 31	23 13	16 29	2 12	4
27	8 40	17 5	22 38	23 7	16 6	1 39	3
28	8 58	17 20	22 45	23 1	15 44	1 6	2
29	9 17	17 34	22 51	22 55	15 21	0 33	1
30	9 25	17 48	22 57	22 48	14 57	0 0	0
	11 Sign	10 Sign	9 Sign	8 Sign	7 Sign	6 Sign	

Add to the *Mean Anomaly* gives the *True*.

The

The EQUATION

Of VENUS' ORBIT.

Venus' Mean Anomaly	*Subtracted* from the *Mean Anomaly* gives the *True*.						Mean Anomaly
	0 Sign	1 Sign	2 Sign	3 Sign	4 Sign	5 Sign	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	
0	0 0	0 23	0 41	0 48	0 41	0 24	30
1	0 0	0 24	0 41	0 48	0 41	0 23	29
2	0 1	0 25	0 42	0 47	0 40	0 22	28
3	0 2	0 25	0 42	0 47	0 40	0 21	27
4	0 3	0 26	0 42	0 47	0 39	0 21	26
5	0 4	0 27	0 43	0 47	0 39	0 20	25
6	0 4	0 28	0 43	0 47	0 39	0 19	24
7	0 5	0 28	0 44	0 47	0 38	0 18	23
8	0 6	0 29	0 44	0 47	0 38	0 18	22
9	0 7	0 30	0 44	0 47	0 37	0 17	21
10	0 8	0 30	0 44	0 47	0 36	0 16	20
11	0 9	0 31	0 45	0 47	0 36	0 15	19
12	0 9	0 31	0 45	0 47	0 35	0 14	18
13	0 10	0 32	0 45	0 46	0 35	0 14	17
14	0 11	0 33	0 46	0 46	0 34	0 13	16
15	0 12	0 33	0 46	0 46	0 34	0 12	15
16	0 13	0 34	0 46	0 46	0 33	0 11	14
17	0 13	0 34	0 46	0 46	0 32	0 10	13
18	0 14	0 35	0 46	0 45	0 32	0 10	12
19	0 15	0 36	0 47	0 45	0 31	0 9	11
20	0 16	0 36	0 47	0 45	0 31	0 8	10
21	0 17	0 37	0 47	0 44	0 30	0 7	9
22	0 17	0 37	0 47	0 44	0 29	0 6	8
23	0 18	0 38	0 47	0 44	0 29	0 5	7
24	0 19	0 38	0 47	0 43	0 28	0 5	6
25	0 20	0 39	0 47	0 43	0 27	0 4	5
26	0 20	0 39	0 47	0 43	0 27	0 3	4
27	0 21	0 40	0 47	0 42	0 26	0 2	3
28	0 22	0 40	0 47	0 42	0 25	0 1	2
29	0 23	0 40	0 47	0 42	0 24	0 0	1
30	0 23	0 41	0 48	0 41	0 24	0 0	0
	11 Sign	10 Sign	9 Sign	8 Sign	7 Sign	6 Sign	

Add to the *Mean Anomaly* gives the *True*.

The

The EQUATION Of the EARTH's ORBIT.

Earth's Mean Anomaly	*Subtracted* from the *Mean Anomaly* gives the *True*.						Mean Anomaly
	0 Sign	1 Sign	2 Sign	3 Sign	4 Sign	5 Sign	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	
0	0 0	0 56	1 39	1 56	1 41	0 59	30
1	0 1	0 58	1 40	1 56	1 40	0 57	29
2	0 3	1 0	1 41	1 56	1 39	0 55	28
3	0 5	1 2	1 42	1 56	1 38	0 53	27
4	0 7	1 3	1 43	1 56	1 37	0 51	26
5	0 9	1 5	1 44	1 56	1 36	0 49	25
6	0 11	1 7	1 45	1 55	1 35	0 48	24
7	0 13	1 8	1 45	1 55	1 33	0 46	23
8	0 15	1 10	1 46	1 55	1 32	0 44	22
9	0 17	1 11	1 47	1 55	1 31	0 42	21
10	0 19	1 13	1 48	1 55	1 30	0 40	20
11	0 21	1 14	1 49	1 54	1 28	0 38	19
12	0 23	1 16	1 49	1 54	1 27	0 36	18
13	0 25	1 17	1 50	1 53	1 26	0 34	17
14	0 27	1 19	1 50	1 53	1 24	0 32	16
15	0 29	1 20	1 51	1 52	1 23	0 30	15
16	0 31	1 22	1 52	1 52	1 21	0 28	14
17	0 33	1 23	1 52	1 51	1 20	0 26	13
18	0 35	1 25	1 52	1 51	1 18	0 24	12
19	0 37	1 26	1 53	1 50	1 17	0 22	11
20	0 38	1 27	1 53	1 49	1 15	0 20	10
21	0 40	1 28	1 54	1 49	1 14	0 18	9
22	0 42	1 30	1 54	1 48	1 12	0 16	8
23	0 44	1 31	1 55	1 47	1 10	0 14	7
24	0 46	1 32	1 55	1 46	1 9	0 12	6
25	0 48	1 33	1 55	1 46	1 7	0 10	5
26	0 49	1 35	1 55	1 45	1 5	0 8	4
27	0 51	1 36	1 55	1 44	1 4	0 6	3
28	0 53	1 37	1 56	1 43	1 2	0 4	2
29	0 55	1 38	1 56	1 42	1 0	0 2	1
30	0 56	1 39	1 56	1 41	0 59	0 0	0
	11 Sign	10 Sign	9 Sign	8 Sign	7 Sign	6 Sign	

Add to the *Mean Anomaly* gives the *True*.

The

The EQUATION Of MARS's ORBIT.

Mars's Mean Anomaly	*Subtracted* from the *Mean Anomaly* gives the *True*.						Mean Anomaly
	0 Sign	1 Sign	2 Sign	3 Sign	4 Sign	5 Sign	
	D. M.	D. M.	D M.	D. M.	D. M.	D. M.	
0	0 0	4 50	8 41	10 35	9 44	5 54	30
1	0 10	4 59	8 47	10 36	9 40	5 44	29
2	0 19	5 7	8 53	10 37	9 35	5 33	28
3	0 29	5 16	8 58	10 38	9 29	5 23	27
4	0 39	5 25	9 4	10 39	9 24	5 12	26
5	0 49	5 34	9 9	10 39	9 18	5 1	25
6	0 59	5 42	9 15	10 40	9 12	4 50	24
7	1 9	5 51	9 20	10 40	9 6	4 39	23
8	1 19	5 59	9 25	10 39	9 0	4 28	22
9	1 29	6 8	9 30	10 39	8 53	4 16	21
10	1 39	6 16	9 35	10 38	8 47	4 5	20
11	1 49	6 24	9 39	10 38	8 40	3 53	19
12	1 59	6 32	9 44	10 37	8 33	3 41	18
13	2 9	6 40	9 48	10 36	8 25	3 30	17
14	2 18	6 48	9 52	10 34	8 18	3 18	16
15	2 28	6 56	9 56	10 33	8 10	3 6	15
16	2 38	7 4	10 0	10 31	8 2	2 54	14
17	2 48	7 12	10 4	10 29	7 54	2 42	13
18	2 58	7 19	10 7	10 27	7 46	2 29	12
19	3 7	7 27	10 10	10 24	7 38	2 17	11
20	3 16	7 34	10 13	10 22	7 29	2 5	10
21	3 26	7 41	10 16	10 19	7 20	1 52	9
22	3 36	7 48	10 19	10 16	7 12	1 40	8
23	3 45	7 55	10 22	10 13	7 2	1 28	7
24	3 54	8 2	10 24	10 9	6 53	1 15	6
25	4 4	8 9	10 27	10 6	6 44	1 3	5
26	4 13	8 15	10 29	10 2	6 34	0 50	4
27	4 22	8 22	10 31	9 58	6 24	0 37	3
28	4 31	8 28	10 32	9 54	6 14	0 25	2
29	4 40	8 35	10 34	9 49	6 4	0 12	1
30	4 50	8 41	10 35	9 44	5 54	0 0	0
	11 Sign	10 Sign	9 Sign	8 Sign	7 Sign	6 Sign	
Add to the *Mean Anomaly* gives the *True*.							

The EQUATION

Of JUPITER's ORBIT.

Jupiter's Mean Anomaly	*Subtracted* from the *Mean Anomaly* gives the *True*.						Mean Anomaly
	0 Sign	1 Sign	2 Sign	3 Sign	4 Sign	5 Sign	
	D. M.	D. M.	D. M.	D M.	D. M.	D. M.	
0	0 0	2 37	4 38	5 31	4 55	2 54	30
1	0 5	2 42	4 41	5 31	4 52	2 49	29
2	0 10	2 47	4 44	5 31	4 50	2 44	28
3	0 16	2 51	4 47	5 31	4 47	2 39	27
4	0 21	2 56	4 49	5 31	4 44	2 33	26
5	0 27	3 1	4 52	5 31	4 40	2 28	25
6	0 32	3 5	4 55	5 31	4 37	2 22	24
7	0 38	3 10	4 57	5 31	4 34	2 17	23
8	0 43	3 14	5 0	5 30	4 31	2 11	22
9	0 48	3 19	5 2	5 30	4 27	2 5	21
10	0 54	3 23	5 4	5 29	4 23	2 0	20
11	0 59	3 27	5 7	3 28	4 20	1 54	19
12	1 5	3 32	5 9	5 27	4 16	1 48	18
13	1 10	3 36	5 11	5 27	4 12	1 42	17
14	1 15	3 40	5 13	5 25	4 8	1 37	16
15	1 21	3 44	5 14	5 24	4 4	1 31	15
16	1 26	3 48	5 16	5 23	4 0	1 25	14
17	1 31	3 52	5 18	5 22	3 56	1 19	13
18	1 36	3 56	5 19	5 20	3 54	1 13	12
19	1 42	4 0	5 21	5 19	3 47	1 7	11
20	1 47	4 4	5 22	5 17	3 43	1 1	10
21	1 52	4 8	5 23	5 15	3 38	0 55	9
22	1 57	4 11	5 25	5 14	3 34	0 49	8
23	2 2	4 15	5 26	5 12	3 29	0 42	7
24	2 7	4 18	5 27	5 10	3 24	0 36	6
25	2 12	4 22	5 28	5 7	3 19	0 30	5
26	2 17	4 25	3 28	5 5	3 15	0 24	4
27	2 22	4 28	5 29	5 3	3 10	0 18	3
28	2 27	4 32	5 30	5 0	3 5	0 12	2
29	2 32	4 35	5 30	4 58	2 59	0 6	1
30	2 37	4 38	5 31	4 55	2 54	0 0	0
	11 Sign	10 Sign	9 Sign	8 Sign	7 Sign	6 Sign	

Add to the *Mean Anomaly* gives the *True*.

The

The EQUATION Of SATURN's ORBIT.

Saturn's Mean Anomaly	*Subtracted* from the *Mean Anomaly* gives the *True*.						Mean Anomaly
	0 Sign	1 Sign	2 Sign	3 Sign	4 Sign	5 Sign	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	
0	0 0	3 4	5 27	6 31	5 51	3 28	30
1	0 6	3 10	5 30	6 31	5 48	3 22	29
2	0 12	3 15	5 34	6 31	5 44	3 16	28
3	0 19	3 21	5 37	6 32	5 41	3 9	27
4	0 25	3 26	5 41	6 32	5 37	3 3	26
5	0 31	3 32	5 44	6 32	5 34	2 56	25
6	0 38	3 37	5 47	6 31	5 30	2 50	24
7	0 44	3 42	5 50	6 31	5 26	2 43	23
8	0 50	3 48	5 53	6 31	5 22	2 37	22
9	0 57	3 53	5 56	6 30	5 18	2 30	21
10	1 3	3 58	5 58	6 29	5 14	2 23	20
11	1 9	4 3	6 1	6 29	5 59	2 16	19
12	1 16	4 8	6 4	6 28	5 5	2 9	18
13	1 22	4 13	6 6	6 27	5 0	2 2	17
14	1 28	4 18	6 8	6 26	4 56	1 55	16
15	1 34	4 23	6 11	6 24	4 51	1 48	15
16	1 41	4 28	6 13	6 23	4 46	1 41	14
17	1 47	4 33	6 15	6 21	4 41	1 34	13
18	1 53	4 37	6 17	6 20	4 46	1 27	12
19	1 59	4 42	6 18	6 18	4 31	1 20	11
20	2 7	4 46	6 20	6 16	4 26	1 13	10
21	2 11	4 51	6 22	6 15	4 20	1 5	9
22	2 17	4 55	6 23	6 12	4 15	0 58	8
23	2 23	4 59	6 24	6 10	4 9	0 51	7
24	2 29	5 3	6 26	6 8	4 4	0 44	6
25	2 30	5 8	6 27	6 5	3 58	0 36	5
26	2 41	5 12	6 28	6 2	3 52	0 29	4
27	2 47	5 15	6 29	6 0	3 46	0 22	3
28	2 53	5 19	6 29	5 57	3 40	0 14	2
29	2 58	5 23	6 30	5 54	3 34	0 7	1
30	3 4	5 27	6 31	5 51	3 28	0 0	0
	11 Sign	10 Sign	9 Sign	8 Sign	7 Sign	6 Sign	

Add to the *Mean Anomaly* gives the *True*.

A TABLE

Shewing the INCLINATIONS, or *Heliocentrick* Latitudes of all the Primary PLANETS, by having their Diſtance from the neareſt *Node*.

Diſt. from neareſt *Node* in Degrees.	☿ D. M.	♀ D. M.	♂ D. M.	♃ D. M.	♄ D. M.
0	0 0	0 0	0 0	0 0	0 0
1	0 7	0 4	0 2	0 1	0 3
2	0 15	0 7	0 4	0 3	0 5
3	0 22	0 11	0 6	0 4	0 8
4	0 29	0 14	0 8	0 6	0 10
5	0 36	0 18	0 10	0 7	0 13
6	0 44	0 21	0 12	0 8	0 16
7	0 50	0 25	0 14	0 10	0 18
8	0 58	0 28	0 16	0 11	0 21
9	1 5	0 32	0 17	0 13	0 24
10	1 13	0 35	0 19	0 14	0 26
11	1 20	0 39	0 21	0 15	0 29
12	1 27	0 42	0 23	0 16	0 31
13	1 34	0 46	0 25	0 18	0 34
14	1 41	0 49	0 27	0 19	0 36
15	1 48	0 53	0 29	0 21	0 39
16	1 55	0 56	0 31	0 22	0 41
17	2 2	0 59	0 32	0 23	0 44
18	2 9	1 3	0 34	0 25	0 46
19	2 16	1 6	0 36	0 26	0 48
20	2 23	1 9	0 38	0 27	0 51
21	2 30	1 13	0 40	0 29	0 54
22	2 37	1 16	0 42	0 30	0 56
23	2 43	1 19	0 43	0 31	0 59
24	2 50	1 23	0 45	0 33	1 1
25	2 57	1 26	0 47	0 34	1 3
26	3 2	1 29	0 49	0 35	1 6
27	3 10	1 32	0 50	0 36	1 8
28	3 16	1 35	0 52	0 38	1 11
29	3 23	1 38	0 54	0 39	1 13
30	3 29	1 42	0 56	0 40	1 15

A TABLE

Shewing the INCLINATIONS, or *Heliocentric* Latitudes of all the Primary PLANETS, by having their Diſtance from the neareſt *Node*.

Diſt. from neareſt *Node* in Degrees.	☿ D. M.	♀ D. M.	♂ D. M.	♃ D. M.	♄ D. M.
30	3 29	1 42	0 56	0 40	1 15
31	3 36	1 44	0 57	0 41	1 17
32	3 42	1 48	0 59	0 42	1 20
33	3 48	1 51	1 0	0 44	1 22
34	3 54	1 53	1 2	0 45	1 24
35	4 0	1 56	1 4	0 46	1 26
36	4 6	1 59	1 5	0 47	1 28
37	4 12	2 2	1 7	0 48	1 30
38	4 18	2 5	1 8	0 49	1 32
39	4 23	2 8	1 10	0 50	1 34
40	4 29	2 11	1 11	0 51	1 37
41	4 35	2 13	1 13	0 52	1 39
42	4 40	2 16	1 14	0 54	1 41
43	4 46	2 18	1 16	0 55	1 42
44	4 51	2 21	1 17	0 56	1 44
45	4 56	2 24	1 19	0 57	1 46
46	5 1	2 27	1 20	0 58	1 48
47	5 6	2 29	1 21	0 59	1 50
48	5 11	2 31	1 23	0 59	1 52
49	5 16	2 33	1 24	1 0	1 53
50	5 21	2 36	1 25	1 1	1 55
51	5 26	2 38	1 26	1 2	1 57
52	5 30	2 40	1 27	1 3	1 58
53	5 35	2 42	1 29	1 4	2 00
54	5 39	2 44	1 30	1 5	2 1
55	5 43	2 46	1 31	1 5	2 3
56	5 47	2 48	1 32	1 6	2 5
57	5 51	2 50	1 33	1 7	2 6
58	5 55	2 52	1 34	1 8	2 7
59	5 59	2 54	1 35	1 8	2 9
60	6 3	2 56	1 36	1 9	2 10

A TABLE

Shewing the INCLINATIONS, or *Heliocentric* Latitudes of all the Primary PLANETS, by having their Diſtance from the neareſt *Node*.

Diſt. from neareſt *Node* in Degrees.	☿ D. M.	♀ D. M.	♂ D. M.	♃ D. M.	♄ D. M.
60	6 3	2 56	1 36	1 9	2 10
61	6 7	2 58	1 37	1 10	2 11
62	6 10	2 59	1 38	1 10	2 13
63	6 13	3 1	1 39	1 11	2 14
64	6 17	3 3	1 40	1 12	2 15
65	6 20	3 4	1 41	1 12	2 16
66	6 23	3 6	1 41	1 13	2 17
67	6 26	3 7	1 42	1 13	2 18
68	6 29	3 8	1 43	1 14	2 19
69	6 31	3 10	1 44	1 14	2 20
70	6 34	3 11	1 44	1 15	2 21
71	6 36	3 12	1 45	1 15	2 22
72	6 39	3 13	1 46	1 16	2 23
73	6 41	3 14	1 46	1 16	2 24
74	6 43	3 15	1 47	1 17	2 24
75	6 45	3 16	1 47	1 17	2 25
76	6 47	3 17	1 48	1 18	2 26
77	6 49	3 18	1 48	1 18	2 26
78	6 50	3 19	1 48	1 18	2 27
79	6 52	3 20	1 49	1 18	2 27
80	6 53	3 20	1 49	1 18	2 28
81	6 54	3 21	1 50	1 18	2 28
82	6 55	3 21	1 50	1 19	2 29
83	6 56	3 22	1 50	1 19	2 29
84	6 57	3 22	1 51	1 19	2 29
85	6 58	3 23	1 51	1 19	2 30
86	6 58	3 23	1 51	1 19	2 30
87	6 59	3 23	1 51	1 19	2 30
88	6 59	3 23	1 51	1 19	2 30
89	6 59	3 23	1 51	1 19	2 30
90	6 59	3 23	1 51	1 19	2 30

The

The foregoing Tables are adapted to the *New Style* *. The firſt Table, *i. e.* for the Years of Chriſt current, exhibits the Diſtances of the Planets from their *Aphelions* on the laſt Day at *Noon* of the preceeding Year. For from thence it is *Aſtronomers* begin their Year, (which holds true alſo of the Months and Days) and not from *Midnight* of the laſt Day, as the *civil* Year begins.—Aſtronomers likewiſe reckon on regularly through the twenty-four Hours, from the *Noon* of one Day to the *Noon* of the following Day. Thus, *January* 10th Day 18th Hour in the aſtronomical Accompt, anſwers to the 11th Day 6 o'Clock in the Morning of the common or vulgar Reckoning. This ſhould be carefully minded, elſe you will be liable to commit great Miſtakes.

It may be neceſſary further to obſerve, that becauſe the *Aphelions* of the Planets have a ſlow progreſſive Motion in the *Ecliptic*, but on the *Inſtrument* are fixed to one particular Point; hence it will come to paſs, that in an Age or two, the Places found by this Method will differ a few Minutes from their true Places in the Heavens †.——But then the

* The Numbers are adapted to the *New Style*, only to give the Learner leſs Trouble in reducing the Old Style to the New before he begins his Calculations, as all Tables are accommodated to that Kind of Reckoning.

† It has been doubted by many Aſtronomers, whether the *Aphelions* and *Nodes* of the Planets are moveable or not.—*Street*, *Whiſton*, and even *Newton*, aſſerted that they are at Reſt, with reſpect to the *fixed Stars*; and conſequently, that they advanced only ſo much as is the *Receſſion* of the *Equinox* (backwards) *Copernicus*, I believe, with *Halley* and *Leadbetter*, made the *Aphelions* advance forward much faſter, and with a Motion different to each other. The Stars ſeem to advance only 1 Degree in 72 Years; but *Saturn*'s *Aphelion* (according to *Leadbetter*) proceeds 1 Degree in 45 Years: *Jupiter*'s, 1 Degree in 50 Years: *Mars*'s, 1 Degree in 51½ Years: *Venus*'s, 1 Degree in 63 Years: and *Mercury*'s, 1 Degree in 69 Years. And upon this Suppoſition the foregoing Tables of the Planets Diſtances from their *Aphelions* are conſtructed.——But if, at laſt, it ſhould be proved that the *Aphelions* do not advance in their Orbs, but continue immoveable with reſpect to the *fixed Stars*, then it will be eaſy to project the *Inſtrument* in ſuch Manner as ſhall make it *perpetual*; and it will become almoſt as uſeful as the large Volumes of Tables, in aſcertaining the true Places and Situations of the *primary Planets* in all Ages from the Creation to the *Flood*,——to the Time of *Heſiod*,——to *Eudoxus*,——to *Aratus*,——to *Hypparchus*,——to *Ptolemy*,——to *Copernicus*,——to *Kepler*,——to *Newton*,——and to the *End* of the great *Platonic Year*.

Inſtrument

Inſtrument may be eaſily projected a new, by the Rules laid down in the former Part of the Book: And, though it ſhould err a few Minutes, it will ſtill have its Uſes in pointing out the Situation of the Triangles made by the Lines in the Heavens at the Time of the Calculations, and thence evidently inform the Learner of the *true Theory* of the *Syſtem*; and by that Means make him Maſter of this fine Science; which is not ſo eaſily to be attained, perhaps, by any other Method.

☞ The SURVEY of the ſeveral SATELLITES attending the *Primary* Planets,——as that belonging to our *Earth*;—the Four of *Jupiter's*, and the Five of *Saturn's*; with the the Poſition of his *Ring* at all Times, will be exhibited in a future Work.

F I N I S.